Study No. 143

Assessment of Pre and Post Harvest Losses of Paddy and Wheat in Assam

Dr. Jotin Bordoloi

Agro-Economic Research Centre for North-East India
Assam Agricultural University, Jorhat-785013
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PREFACE

The study on "Assessment of Pre and Post Harvest Losses of Paddy and Wheat in Assam'' was undertaken by the Centre at the instance of the Ministry of Agriculture, Government of India. The Agricultural Development and Rural Transformation (ADRT), centre attached to the Institute for Social and Economic Change (ISEC), Bangalore was designated as the coordinating centre for the study. The draft report was submitted to the coordinating centre for comments and necessary corrections and modifications have been incorporated in the final report.

As per approved design, the present study was conducted based on primary and secondary level information/data. The secondary level analysis was based on the data available in the Reports of the Commission for Agricultural Costs and Prices; Department of Agriculture and Cooperation, Government of India and the data on APY of the mandated Crops (paddy and wheat) published by the Directorate of Economics and Statistics, Government of Assam. For primary level data, two major paddy growing districts were selected from two different agro-climatic zones. The districts of Sonitpur and Golaghat were selected from the North Bank Plain Zone and the Upper Brahmaputra Valley Zone, respectively. Similarly, two major wheat growing districts, *viz.*, Morigaon from the Central Brahmaputra Valley Zone and Borpeta from the Lower Brahmaputra Valley Zone were selected.

Crop losses occur due to two types of factors- abiotic and biotic factors. Crop losses due to abiotic factors like flood, draught and other natural factors are beyond the ambit of the present study. Crop losses due to biotic factors such as pest and diseases, weeds, stray cattle, rodents, birds, *etc*. can be controlled to a great extent if proper measures are taken at the right time. Pre harvest losses are mainly caused by the attack of pest & diseases and the post harvest losses are witnessed at different stages. Both the losses were estimated in terms of production and productivity of grains for the reference year. In the final analysis, the pre harvest losses were recorded at 2.49 quintal/ha in case of paddy and 2.96 quintal/ha in case of wheat while post harvest losses were recorded at 2.55 quintal/ha in case of paddy and 2.14 quintal/ha in case of wheat. Total losses stood at 5.04 quintal/ha for paddy and 5.10 quintal/ha for wheat.

On that count, the estimated total loss of paddy and wheat for the state as a whole were worked out as 8.56 lakh MT and 0.20 lakh MT, respectively. This figure could have fed as many as 81.79 lakh population of Assam. We just cannot afford to allow such huge losses as our food requirement is on the rise every year.

Under the circumstances, I hope that the report will provide first-hand information on crop losses particularly of paddy & wheat and help formulating appropriate policies to reduce the losses in the state.

Like all other studies, this is also a joint output of the Centre. The names of the research staff associated with the study have been mentioned elsewhere in the report.

I sincerely acknowledge with thanks for the help & cooperation rendered by the officials of concerned District Agricultural Offices of the state. I am also thankful to all the sample respondents for their spontaneous help and co-operation during the field surveys.

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Chapter I

Introduction

1.1 Status of Agricultural Economy of the State

As per census of 2011, 85.92 per cent of the total population of the state lives in rural areas. Agriculture is the main source of livelihood of this segment of the population. The agriculture sector alone gives employment to 53.01 per cent of the working population of the state (Table 1.1).

Table-1.1
Status of Farmers in Assam

No. of Agricultural Labourers (In Lakh)	**No. of cultivators** (In Lakh)	**P.C. of agricultural working force of the total working force in the State**
27.50	37.31	53.01

Source: The Directorate of Economics and Statistics, Assam

This sector has vital importance from the point of food security of 3.12 crore (2011) population of the state. The agriculture and allied sector contributed 22.40 per cent to the total GSDP (Rs.80,465.13 crore) of the state at constant prices (2004-05) while the service sector and industry sector contributed 55.70 and 21.90 per cent, respectively in 2011-12. The growth of the GSDP of the agriculture & allied sector at 2004-05 prices was 6.43 per cent (Adv.estimate) in 2011-12 (Q.E) over the previous year (2010-11).

The trend of growth of agricultural sector (GSDP at constant prices 2004-05) is shown in Table-1.2. The share of the agriculture & allied sector to the GSDP is showing a gradual fall from 21.39 per cent in 2005-06 to 19.22 per cent in 2010-11. But the annual growth of the GSDP had shown a significant increase from 1.9 per cent to 7.5 per cent during 2005-06 to 2010-11(Table-1.2).

Table-1.2
Trend of growth of agricultural sector
(GSDP at constant prices 2004-05)

(Figures in percentage)

Year	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10(P)**	**2010-11**
Share to GSDP	21.39	20.78	20.43	19.56	19.18	19.22
Annual growth over the previous year	1.9	1.7	3.0	1.2	5.9	7.5

Source: The Directorate of Economics and Statistics, Assam

Soils of Assam

Soils of Assam have been categorized in five orders. As per local name, the highest 41.4 per cent falls under Brahmaputra alluvial/old soil (Inceptisols) followed by 33.6 per cent under the recent alluvial soils/sandy soils (Entisols),11.3 per cent under the red soils (Alfisols), 5.6 per cent under the red soils (Ultisols) and the rest 8.1 per cent belonged to the miscellaneous category,(Table-1.3).

Table-1.3
Distribution of soils in Assam under the different categories

(Area **in thousand hectare**)

Sl. No.	**Soil order**	**Area**	**Percentage of Soils**	Local name
1	Inceptisols	3245.3	41.4%	Brahmaputra alluvial soils, Old
2	Entisols	2640.1	33.6%	Recent alluvial soils, Sandy soils
3	Alfisols	886.9	11.3%	Red Soils
4	Ultisols	436.5	5.6%	Red soils
5	Miscellaneous	635.2	8.1%	-
Total	-	**7844.0**	**100%**	-

Source: The Directorate of Economics and Statistics, Assam

Soil nature

Soil of the state is acidic in nature. Of the total geographical area (7,850 thousand hectares), 0.30 per cent is strongly acidic, 31.50 per cent moderately acidic, 31.10 per cent slightly acidic, 29.20 per cent neutral and 7.9 per cent belongs to other categories. (Table-1.4)

Table-1.4
Soil reaction (P^H) class of Soils in Assam

Type	**Geographical Area** (Area in lakh hectare)	**% to Geographical Area**
Strongly Acidic (P^H < 4.5)	0.24	0.30%
Moderately Acidic (P^H 4.5 – 5.5)	24.71	31.50%
Slightly Acidic (P^H 5.5 – 6.5)	24.39	31.10%
Neutral (P^H > 6.5)	22.90	29.20%
Others	6.19	7.90%

Source: The Directorate of Economics and Statistics, Assam

Soils of Assam are highly deficit in zinc (34%) and manganese (20%). Micronutrient deficiency in soils of Assam is given in Table- 1.5.

Table-1.5
Micronutrient deficiency in soils of Assam

(percentage of deficiency)

Zinc	**Copper**	**Iron**	**Manganese**	**Boron**	**Molybdenum**
34%	<1%	2%	20%	-	-

Source: The Directorate of Economics and Statistics, Assam

Table-1.6 gives the trend of land use pattern and cropping intensity during 2000-01 to 2009-10.The geographical area of the state was recorded at 7843 thousand hectares in 2000-01 which was then recorded at 7850 thousand hectares in 2008-09 with an increase of 7 thousand hectares as per report of the geographical survey of the state. The area was found a nominal increase under net area shown but the area under shown more than once and total cropped area were found decrease during 2000-01 to 2009-10. The CGR of grew at the rate of 0.04 per cent against the net area sown, -0.36 per cent against the area sown more than once, -0.07 per cent against the total cropped area. The cropping intensity had decreased insignificantly from 146.51 in 2000-01 to 145.82 per cent 2009-10. The CGR of cropping intensity was recorded at -0.12 per cent per annum during the reference period.

Table-1.6
Trend of Land use pattern and cropping intensity in Assam

(Area in 000' hectare)

Year	Geographical area	Net area shown	Area sown more than once	Total cropped area	Cropping intensity
2000-01	7843	27.93	12.99	40.92	146.51
2001-02	7843	27.74	12.09	39.83	143.58
2002-03	7843	27.53	12.05	39.58	143.77
2003-04	7843	27.53	12.04	39.57	143.73
2004-05	7843	27.53	11.43	38.96	141.52
2005-06	7843	27.53	11.96	39.49	143.44
2006-07	7843	27.53	10.10	37.63	136.69
2007-08	7843	27.53	10.86	38.39	139.45
2008-09	7850	28.10	11.89	39.99	142.31
2009-10	7850	28.11	12.88	40.99	145.82
CGR	-	0.04	-0.36	-0.07	-0.12

Source: The Directorate of Economics and Statistics, Assam

Cropping pattern

The type of soil, the type of agro-climatic condition, the extent of rainfall, the irrigation status, the social back ground, the economic condition of the farmers and the economic return or monetary gain per unit of area basically determine the cropping pattern of a region or a state. Also, agricultural economic policies of each of the Five Year Plans do have significant bearing on changing cropping pattern of a state. As Assam is situated in heavy rainfall zone, it follows a rice-based cropping system which is adopted in the entire Eastern part of the India. To ensure good yield, it needs supplemented irrigation if there is any shortfall of rain in the growing season of the crops. Reports say that, if crop has to depend solely on rainfall, it requires not less than 30 cm per month of rains over the entire growing period.

The crop season of the state is basically divided into two main seasons- *Kharif* from April to September and *Rabi* from October to March. Some of the crops are grown in a particular season while some other crops are grown in both the seasons, depending upon the seed varieties and its suitability to climatic conditions. The main cereal crops of *Kharif* season of Assam include Rice Normal *Ahu* (Direct seeded), Rice Normal *Ahu* (Transplanted), *Sali* Rice, *Bao* Rice and Maize. *Kharif* pulses include Black gram, Green gram and *Arhar*. Sesamum, Groundnut, *etc.* are the oil seed crops of *Kharif* season. The fiber crops include jute, mesta, cotton and ramie. Both cotton and ramie cover a significant area. *Boro* rice (Suumer paddy), early *ahu* (direct seeded/transplanted), wheat, *rabi* maize, *etc.*, are the cereals grown in the state during *rabi* season. Summer black gram/green gram, lentil, pea, grass pea (*Khesari*), *etc.*, are the pulses; rapeseed-mustard, linseed, niger, *rabi* ground nut etc., are the oilseeds and potato is grown as tuber crop. In addition, different types of vegetables and spice crops (mainly, ginger and turmeric) are grown in the both the *Kharif* and *Rabi* seasons as well. The area under *Kharif* and *Rabi* vegetables are also on the rise as reflected in the statistics available with the Economic Survey of Assam, 2011-12.

Winter rice occupies the highest proportion of area and is followed by summer and autumn rice.

The state is divided into 6 agro-climatic zones. Zone wise cropping pattern of the state is given in Table 1.7.

Table-1.7
Zone wise cropping pattern of the state

Zone	Major crops	Other crops	Horticultural Crops	Major Cropping Pattern
North Bank Plains Zone	Winter (*Sali*) Paddy, Deep Water (*Bao*) Paddy, Autumn (*Ahu*) Paddy, *Boro* Paddy	Mustard, Pulses, Maize & Jute.	Black Pepper, Banana, Ginger, Pineapple, Orange, Litchi, Assam Lemon, & Vegetables.	Winter (*Sali)* Paddy – Summer (*Boro*) Paddy/ *Rabi* Vegetables/ *Rabi* Oilseeds / *Rabi* Pulses/ Sugarcane
Upper Brahmaputra Valley Zone	Winter (*Sali*) Paddy.	Mustard, Pulses, Sugarcane & Maize	Black Pepper, Banana, Ginger, Orange, Assam Lemon, Vegetables & Arecanut.	Winter (*Sali*) Paddy – *Rabi* Oilseeds/ Rabi Vegetables / Rabi Pulses/ Sugarcane
Central Brahmaputra Valley Zone	Winter Paddy, Summer Paddy, Jute, Sugarcane, Vegetables & Oilseeds.	Maize & Pulses	Banana, Assam Lemon, Arecanut & Coconut.	Winter (*Sali*) Paddy – Summer (Boro) Paddy / *Rabi*Vegetables / Rabi Oilseeds / *Rabi* Pulses – Summer Vegetables , Jute – Summer Paddy/ Sugarcane

Contd../-

Contd. Table-1.7

Zone	Major crops	Other crops	Horticultural Crops	Major Cropping Pattern
Lower Brahmaputra Valley Zone	Winter (*Sali*) Paddy, Summer (*Boro*) Paddy, Autumn (*Ahu*) Paddy, Maize, Pulses, Oilseeds, Jute & Vegetables.	Sugarcane.	Cashew nut, Banana, Assam Lemon, Orange, Pineapple, Arecanut & Coconut.	Winter (*Sali)* Paddy – Summer (*Boro*) Paddy / *Rabi*Vegetables / Rabi Oilseeds / *Rabi* Pulses – Summer Vegetables *Sali* Paddy – *Rabi* Oilseeds / *Rabi* Pulses, Jute – Summer (*Boro*) Paddy/ Sugarcane
Barak Valley Zone	Winter (*Sali)* Paddy, Autumn (*Ahu)* Paddy	Summer (Boro) Paddy, Sugarcane	French Bean, Ginger, Vegetables Pineapple & Arecanut.	Winter (*Sali)* Paddy – Autumn (*Ahu*) Paddy /Summer Vegetables/ Sugarcane
Hill Zone	Winter (*Sali)* Paddy, Autumn (*Ahu)* Paddy, Summer (*Boro*) Paddy, Maize, Sugarcane	Oilseeds & Pulses.	Pineapple, Orange & other citrus crops, Ginger, Vegetables & Arecanut	Winter (*Sali)* Paddy – Maize / Rabi Vegetables/ Sugarcane

Source: The Directorate of Economics and Statistics, Assam

Cropping pattern gives the proportion of changes of area under different crops grown over the gross cropped area in the state during the period under observation. The changes in cropping pattern in Assam can be gazed from Table-1.8 during 2000-01 to 20010-11. Rice is the principal crop of Assam which dominates the cropping pattern of the state. It is cultivated in three seasons *viz.* autumn, winter and summer season. The area under autumn rice was found to decrease (-4.94%) while area under winter (0.19 %) and summer rice (1.87 %) were found to increase over the years. The area under total rice (-0.43%) was found to decrease in the reference period. It had happened due to decrease of area under the autumn rice. The area was also found to decrease in case of wheat (-3.93%), maize (-0.81%), pulses (-0.47%), food-grains (-0.45%), Oilseeds (-2.52 %), (including mustard & rape seeds and other oil seeds such as sesamum, nizer, *etc.*) and fibre crops (-1.08%). The area under sugarcane was found to increase at the rate of 1.06 per cent per annum. It increased due to price hike of molasses and the demand of sugarcane sticks for juice in the cities and towns as soft drinks during summer season. The overall gross cropped area was also decreasing in the state during the reference period at the rate of -0.14 per cent per annum.

Table-1.8
Trend of cropping pattern of major crops in Assam during 2000-01 to 2010-11

Year	Autumn Rice	Winter Rice	Summer Rice	Total Rice	Wheat	Maize	pulses	food - grains	Oil seeds	fibre	Suger cane	Gross cropped
2000-01	5.40 (13.20)	17.77 (43.43)	3.29 (8.04)	26.46 (64.66)	0.70 (1.71)	0.20 (0.49)	1.23 (3.01)	28.35 (69.28)	3.36 (8.21)	0.75 (1.83)	0.27 (0.66)	40.92
2001-02	4.96 (12.45)	17.14 (43.03)	3.26 (8.18)	25.36 (63.67)	0.72 (1.81)	0.20 (0.50)	1.30 (3.26)	27.32 (68.59)	3.39 (8.51)	0.73 (1.83)	0.27 (0.68)	39.83
2002-03	4.64 (11.72)	17.49 (44.19)	3.27 (8.26)	25.41 (64.20)	0.69 (1.74)	0.20 (0.51)	1.23 (3.11)	27.26 (68.87)	3.39 (8.56)	0.73 (1.84)	0.25 (0.63)	39.58
2003-04	4.41 (11.14)	17.69 (44.71)	3.19 (8.06)	25.30 (63.94)	0.70 (1.77)	0.20 (0.51)	1.26 (3.18)	27.19 (68.71)	3.03 (7.66)	0.69 (1.74)	0.25 (0.63)	39.57
2004-05	4.36 (11.19)	16.36 (41.99)	3.11 (7.98)	23.83 (61.17)	0.64 (1.64)	0.19 (0.49)	1.15 (2.95)	25.89 (66.45)	2.84 (7.29)	0.63 (1.62)	0.24 (0.62)	38.96
2005-06	3.98 (10.08)	17.07 (43.23)	3.15 (7.98)	24.20 (61.28)	0.50 (1.27)	0.19 (0.48)	1.07 (2.71)	26.04 (65.94)	2.48 (6.28)	0.62 (1.57)	0.23 (0.58)	39.49
2006-07	3.79 (10.07)	14.98 (39.81)	3.12 (8.29)	21.90 (58.20)	0.60 (1.59)	0.19 (0.50)	1.14 (3.03)	23.90 (63.51)	2.76 (7.33)	0.63 (1.67)	0.27 (0.72)	37.63
2007-08	3.54 (9.22)	16.47 (42.90)	3.23 (8.41)	23.24 (60.54)	0.56 (1.46)	0.18 (0.47)	1.17 (3.05)	25.22 (65.69)	2.77 (7.22)	0.65 (1.69)	0.26 (0.68)	38.39
2008-09	3.51 (8.78)	17.73 (44.34)	3.60 (9.00)	24.84 (62.12)	0.50 (1.25)	0.17 (0.43)	1.18 (2.95)	26.42 (66.07)	2.67 (6.68)	0.65 (1.63)	0.29 (0.73)	39.99
2009-10	3.46 (8.44)	17.89 (43.64)	3.94 (9.61)	25.30 (61.72)	0.60 (1.46)	0.19 (0.46)	1.19 (2.90)	26.99 (65.85)	2.76 (6.73)	0.70 (1.71)	0.27 (0.66)	40.99
2010-11	3.13 (7.96)	18.59 (47.31)	3.99 (10.15)	25.71 (65.42)	0.45 (1.15)	0.20 (0.51)	1.26 (3.21)	27.66 (70.39)	2.72 (6.92)	0.67 (1.70)	0.30 (0.76)	39.30
CGR	-4.94	0.19	1.87	-0.43	-3.93	-0.81	-0.47	-0.45	-2.52	-1.08	1.06	-0.14

Note: Figures in parentheses indicate percentage area under crops to the gross cropped area of the state.

Form the foregoing analysis; one can see that there were no significant changes in cropping pattern in the state during the period of study. Most of the time, seed was considered to be a major constraint. Existing irrigation facilities have not been utilized fully by the farmers due to some technical loopholes in the irrigation system. Rising input cost in one hand and lower productivity on the other, have resulted in continuous decline in profit per unit of land. Poor mechanization of agricultural activities & inefficient market net work also dampened the spirit of the farmers in accepting/ trying new crops. Higher production at a low cost is the solution of the problem and this can be accomplished by increasing the productivity per unit of land in consideration of the limitation of arable land in the state. Together with this, gross cropped area can be increased by double or multiple cropping practices as well..

Table -1.9 gives the percentage of farm families and the area of operational holding by size groups as per Agricultural Census, 2005-06 in Assam.Of the total farm families (27.50 lakh), 85.25 per cent (all India: 81.30%) belonged to small and marginal, 11.58 percent to semi medium, 3.02 per cent to medium, 0.13 per cent to large farm size groups. Of the total operated area (30.49 lakh hectare), the small and marginal groups covered an area of 48.49 percent; semi medium group covered an

area of 27.75 per cent; medium size group covered an area of 13.95 percent while large size group covered an area of 9.80 per cent. The average size of operational holding stood at 0.63 hectares for marginal and small size, 2.66 hectares for semi medium, and 5.13 hectares for medium and 60.92 hectares for large size family group. The overall average size of operational holding stood at 1.11 hectare per farm family against the national average of 1.13 hectares. Women farmers were 49.62 thousand constituting 1.80 per cent of the total farmers of the state (37.31 lakh) in the reference year. It has been observed that most of the farm families of marginal and small size group have started using tractor/ power tiller on custom hiring basis which reduces the usual expenditure on bullock and other tools and implements.

Table-1.9
Percentage of farm families and area of operation holding by size groups in Assam

(Agriculture Census, 2005-06)

Size (in hectare)	**Percentage of farm families to the total**	**Percentage of total operated area to the total**	**Av. Size of operational holding per Family** (In hectare)
Marginal(less than 1.00)	63.74	24.93	0.43
Small (1.00-2.00)	21.51	23.56	1.21
Total (Small & Marginal)	**85.25 (National: 81.30)**	**48.49**	0.63
Semi Medium (2.00-4.00)	11.56	27.75	2.66
Medium (4.00-10.00)	3.02	13.95	5.13
Large (1o & more)	0.18	9.80	60.92
Total farm families (In lakh)	**27.50**		**1.11 (National Av.: 1.13)**
Women farmers (In thousands)	**49.62** (1.80 %)	-	-
Total area of operational holding (In Lakh Hectare)	-	**30.49**	-

Source: The Directorate of Economics and Statistics, Assam

The trend of growth of area, production and productivity of major crops during 2000-01 to 2010-11 in the state is given in Table 1.10, 1.11 and 1.12. The positive CGR of area was found against three crops *viz.*, winter rice (0.19 %), summer rice (1.87 %) and sugarcane (1.06%) and the negative CGR was found against 9 crops *viz.*, autumn rice (-4.94 %), total rice (-0.43%), wheat (-3.93 %), maize (-0.81%), total pulses (-0.47%), total food-grains (-0.45%), total oilseeds (-2.50%),and jute (-1.17%). There has been no growth in case of mesta growth (0.00 %). In case of production, the positive CGR was found against 5 crops *viz.*, winter rice (1.40%), summer rice (4.02%), total rice (1.33%), total food grains (1.22 %) and sugarcane (1.23 %) while the negative CGR was found against 6 crops *viz.*, autumn

rice (-3.87%), wheat (-3.43%), maize (-0.83%), total pulses (-0.09%), total oilseeds (-2.52%) and jute (-0.004) and and no growth was recorded for mesta. In case of productivity, positive growth was recorded in 11 crops except total oilseeds (-0.01%).

Table-1.10

Area, Production and Yield of crops in Assam from 2000-01 to 2010-11

(Area in lakh hectares, Production in lakh MT, Yield in Kg. per ha.)

Crop	Autumn Rice			Winter Rice			Summer Rice			Total Rice		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y
2000-01	5.40	5.38	1050	17.77	27.80	1576	3.29	6.80	2068	26.46	39.98	1531
2001-02	4.96	4.88	1000	17.14	27.13	1607	3.26	6.53	2003	25.36	38.54	1540
2002-03	4.64	4.45	973	17.49	26.71	1550	3.27	6.22	1901	25.41	37.38	1491
2003-04	4.41	4.30	991	17.69	28.77	1651	3.19	5.73	1794	25.30	38.81	1555
2004-05	4.36	2.86	667	16.36	25.74	1598	3.11	6.10	1959	23.83	34.70	1475
2005-06	3.98	3.98	1016	17.07	25.94	1543	3.15	5.60	1780	24.20	35.52	1487
2006-07	3.79	3.36	899	14.98	19.50	1321	3.12	6.30	2017	21.90	29.16	1349
2007-08	3.54	3.48	999	16.47	22.39	1380	3.23	7.32	2267	23.24	33.19	1428
2008-09	3.51	3.74	1084	17.73	29.24	1674	3.60	7.72	2142	24.84	40.70	1638
2009-10	3.46	3.35	982	17.89	32.14	1824	3.94	8.60	2180	25.30	44.08	1765
2010-11	3.13	3.56	1155	18.59	36.49	1993	3.99	10.28	2577	25.71	50.33	1983
CGR	**-4.94**	**-3.87**	**0.95**	**0.19**	**1.40**	**1.24**	**1.87**	**4.02**	**2.11**	**-0.43**	**1.33**	**1.71**

Source: The Directorate of Economics and Statistics, Assam

Table 1.11

Area, Production and Yield of crops in Assam from 2000-01 to 2010-11

(Area in lakh hectares, Production in lakh MT, Yield in Kg. per ha.)

Year	Wheat			Maize			Total Pulses			Total Food grains		
	A	**P**	**Y**	**A**	**P**	**Y**	**A**	**P**	**Y**	**A**	**P**	**Y**
2000-01	0.70	0.86	1219	0.20	0.15	722	1.23	0.68	556	28.35	41.7	1472
2001-02	0.72	0.85	1181	0.20	0.14	711	1.30	0.72	556	27.32	40.3	1475
2002-03	0.69	0.78	1129	0.20	0.15	716	1.23	0.67	539	27.26	39	1431
2003-04	0.70	0.73	1046	0.20	0.14	718	1.26	0.69	546	27.19	40.4	1486
2004-05	0.64	0.68	1066	0.19	0.14	721	1.15	0.66	568	25.89	36.2	1416
2005-06	0.50	0.54	1076	0.19	0.14	725	1.07	0.57	533	26.04	36.8	1431
2006-07	0.60	0.67	1132	0.19	0.14	744	1.14	0.62	542	23.90	30.6	1298
2007-08	0.56	0.71	1263	0.18	0.13	725	1.17	0.64	544	25.22	34.7	1393
2008-09	0.50	0.65	1300	0.17	0.13	726	1.18	0.73	617	26.42	42.2	1599
2009-10	0.60	0.65	1087	0.19	0.14	718	1.19	0.67	560	26.99	45.6	1688
2010-11	0.45	0.56	1256	0.20	0.14	714	1.26	0.70	557	27.66	51.8	1893
CGR	**-3.93**	**-3.43**	**0.61**	**-0.81**	**-0.83**	**0.06**	**-0.47**	**-0.09**	**0.35**	**-0.45**	**1.22**	**1.76**

Source: The Directorate of Economics and Statistics, Assam

Table 1.12

Area, Production and Yield of crops in Assam from 2000-01 to 2010-11

(Area in lakh hectares, Production in lakh MT, Yield in Kg. per ha., Jute in Lakh Bales, Sugarcane in numbers)

Year	Total Oilseeds			Jute			Mesta			Sugarcane		
	A	**P**	**Y**	**A**	**P**	**Y**	**A**	**P**	**Y**	**A**	**P**	**Y**
2000-01	3.36	1.86	554	0.70	1.20	1730	0.05	0.05	875	0.27	9.88	36898
2001-02	3.39	1.89	558	0.68	1.22	1781	0.05	0.04	887	0.27	10.11	37230
2002-03	3.39	1.90	562	0.68	1.24	1830	0.05	0.05	892	0.25	9.16	36422
2003-04	3.03	1.61	531	0.64	1.20	1870	0.05	0.05	893	0.25	9.81	38589
2004-05	2.84	1.52	536	0.58	0.74	1274	0.05	0.05	897	0.24	8.84	36919
2005-06	2.48	1.17	472	0.57	1.04	1836	0.05	0.05	905	0.23	8.71	37190
2006-07	2.76	1.37	497	0.58	1.01	1744	0.05	0.05	913	0.27	10.55	39634
2007-08	2.77	1.45	524	0.60	1.18	1976	0.05	0.05	922	0.26	9.80	38075
2008-09	2.67	1.53	574	0.60	1.17	1939	0.05	0.05	913	0.29	11.00	38387
2009-10	2.76	1.46	529	0.65	1.28	1967	0.05	0.04	916	0.27	10.62	39110
2010-11	2.72	1.58	581	0.62	1.13	1808	0.05	0.05	940	0.30	10.76	36196
CGR	-2.5	-2.52	-0.01	-1.17	-0.0040	1.11	0.00	0	0.58	1.06	1.23	0.28

Source: The Directorate of Economics and Statistics, Assam

Table- 1.13 depicts Assam's share in India in respect of area coverage and production in respect major crops during 2010-11. In case of area, rice covered 6.04 per cent,

wheat 0.15 per cent, maize 0.24 per cent, pulses 0.48 per cent, food-grains 2.20 per cent, oilseeds 1.01 per cent, jute 8.05 per cent and sugarcane covered 0.61 per cent of the total area under respective crops at all India level while in production, Assam's share in all India was at 5.28 per cent in rice, 0.07 per cent in wheat, 0.07 per cent in maize, 0.39 per cent in pulses, 2.14 per cent in food-grains,0.51 per cent in oilseeds, 6.26 per cent in jute, and 0.32 per cent in sugarcane during 2010-11.

Table 1.13
Assam's share in India in respect of Area Coverage & Production of Field Crops, (2010-11)

	Area Coverage (In lakh hectares)		Production (Lakh MT, Jute in lakh bales)			
Crop	**Assam**	**India**	**Assam's share**	**Assam**	**India**	**Assam's share**
Rice	25.71	425.6	6.04%	50.33	953.3	5.28%
Wheat	0.45	292.5	0.15%	0.56	859.3	0.07%
Maize	0.2	84.9	0.24%	0.14	212.8	0.07%
Pulses	1.26	262.8	0.48%	0.7	180.9	0.39%
Foodgrains	27.66	1257.3	2.20%	51.76	2415.7	2.14%
Oilseeds	2.72	268.2	1.01%	1.58	311	0.51%
Jute	0.62	7.7	8.05%	6.26	100	6.26%
Sugarcane	0.3	49.4	0.61%	10.76	3391.7	0.32%

Source: The Directorate of Economics and Statistics, Assam

Table-1.14 shows difference in yield of major crops in Assam and all India level. It clearly indicates that the yield of all the crops grown in Assam is far behind the national average that the state is lag behind in the yield compared to all India. Hence, a review of application of ongoing modern technology to find out the root causes of difference in productivity of the crops.

Table-1.14
Yield of major crops of Assam *vis a vis* India in 2010-11

Crop	Yield (Kg per hectare)		Yield difference
	Assam	**India**	
Rice	1983	2240	257(12.96%)
Wheat	1256	2938	1682(133.92%)
Maize	714	2507	1793(251.12%)
Pulses	557	689	132(23.70%)
Food grains	1893	1921	28(1.48%)
Oilseeds	581	1159	578(99.48%)
Jute & Mesta	1808	2212	404(22.35%)
Sugarcane	36196	68596	32400(89.51%)

Source: The Directorate of Economics and Statistics, Assam

1.2 Importance of the selected crops in the state

In this study two crops were selected- paddy as a first crop and wheat as a second crop. Paddy is the principal crop of Assam. Wheat occupies the second

position next to paddy in the food dish of the people of Assam. The losses of these two crops at different stages are a matter of great concern for food security of the growing population and the farm economy as well. The study on wheat has got a special importance in the sense that it fails to show a satisfactory result in terms of production and productivity in the state during the last decade. It has been observed that the farmers of the State are not willing to go for wheat cultivation in extensive way. As reported, the climate of the state is not suitable for growing wheat. The crop is very much sensitive to pests and diseases infestation. Also post harvest operation like threshing & storing are not that easy because of high humidity content.

It has been observed that the present technologies are available to minimize the pre harvest losses to a great extent but the State has to do a lot to reduce the post-harvest losses.

1.3 Background of Pre and Post Harvest Losses

"Indian farming suffers losses of up to Rs.1 lakh crore from pest and diseases annually apart from natural calamities." (The Times of India, September 10, 2012, P.Chengal Reddy, Secretary General, Consortium of Indian Farmers Association). In a country with vast population like India crop losses at any stage is a serious matter which needs proper intervention to reduce such losses on priority basis of the demand of the crops.

Indian agriculture has undergone considerable transformations over time. The transformations are seen in the form of changes in agrarian structure, technological interventions, cropping pattern, enterprise mix and marketing system. During 1960s and 1970s, much emphasis was placed on increasing agricultural production through adoption of high yielding varieties along with use of chemical fertilizers and pesticides. This had led to intensive use of land and agricultural inputs particularly in the regions endowed with irrigation facilities. The periods of 1980s and 1990s had witnessed crop diversification and emergence of allied enterprises like dairying and animal husbandry. The commodity specific programmes like technology mission on oilseeds were launched during this period. During 2000s, the nature of demand for agricultural commodities has changed for both domestic and foreign requirements. The food consumption pattern has shifted from cereals to high value commodities like fruits, vegetables and livestock products. Trade liberalization has led to production of such commodities which have export demand in the world market. These developments in a way have altered a multi commodity production system to a

specialized system in different parts of the country. In the process, many traditionally cultivated crops (e.g. coarse cereals and small millets) either have lost their area or gone out of cultivation. But, these developments have entailed increased buildings up of pest and diseases, and consequently use of higher amount of pesticides to raise the crop productivity. The increased use of pesticides has also resulted in developing insects and disease resistance, which further led to reduction in crop yield.

1.3.1 **Pre harvest Losses**

The estimation of crop loss due to pests and diseases is a complex subject. It is in fact, difficult to assess the loss caused by the individual pest as a particular crop may be infested by the pest complex in the farmers' field conditions. Further, extent of crop loss either physical or financial depends on the type of variety, stage of crop growth, pest population and weather conditions. Nevertheless, the crop loss estimates have been made and updated regularly at global level. The worldwide yield loss due to various types of pest was estimated at 37.4 per cent in rice, 28.2 per cent in wheat, 31.2 per cent in maize and 26.3 per cent in soybean (Oerke, 2007). At all India level, crop loss estimates due to insect pests have been provided by Dhaliwal *et.al* (2010). According to these sources, the crop loss was estimated at 25 per cent in rice and maize, 5 per cent in wheat, 15 per cent in pulses and 50 per cent in cotton. The crop loss has increased during post-green revolution period. The severity of pest problems has reportedly been changing with the developments of agricultural technology and modification of agricultural practices. The damage caused by major inspect-pests in various crops has also been compiled and reported by Reddy and Zehr (2004). Further, a number of studies have established the strong relationship between pest infestation and yield loss in various crops in India (Nair, 1975; Dhaliwal and Arora, 1994; Muralidharan, 2003; Rajeswari *et al*, 2004; Muralidharan and Pasalu, 2006; Rajeswari and Muralidharan, 2006).

Generally, crop losses are estimated as the difference between potential (attainable yield) and the actual yield. The potential yield is the yield that would have been obtained in the absence of pest under consideration. By multiplying the area with the estimated yield loss, total loss is obtained. To estimate the crop loss, most of the existing studies have adopted experimental treatment approach (with or without pest attack) through artificial infestation or field with natural infestation wherein half of the field is protected against the pest while the other half is not. But, the results obtained from artificial infestation or natural infestation in the selected plots/field will

not be appropriate for extrapolation over a geographical area (Groote, 2002). It is for the reason that the estimated crop losses under these conditions may not represent the actual field conditions or farmers. Alternatively, the estimates collected directly from the farmers through sample survey may be reliable and could be used for extrapolation in similar geographical settings. However, the farmers' estimates are likely to be subjective and these should be validated with estimates worked out by the expert of the State Department of Agriculture.

1.3.2 Post Harvest Losses

Production in agriculture is seasonal and is exposed to natural environment. The post-production operations play an important role in providing stability to the food supply chain. According to a World Bank (1999) study, the post harvest losses of food grains in India are 7-10 per cent of the total production from farm to market level and 4-5 percent at market and distribution level. Given the total production of around 240 million tonnes of food-grains at present, the total losses is worked out around 15-25 million tonnes. With the given per capita cereal consumption requirement for India, the above quantity of grains lost would be sufficient to feed more than 10 crore people. Losses in food crops occur during harvesting, threshing, drying, storage, transportation, processing and marketing. In the field and during storage, the products are threatened by insects, rodents, birds and other pests. Moreover, the product may be spoiled by infection from fungi, yeasts or bacteria. Food grain stocks suffer qualitative and quantitative losses while in storage. The quantitative losses are generally caused by different factors, *viz.*, incidence of insect infestation, rodents, and birds and also due to physical changes in temperature, moisture content, *etc*. The qualitative loss is caused by reduction in nutritive value due to factors, such as attack of insect pest, physical changes in the grain and chemical in the fats, carbohydrates, protein and also by contamination of myco toxins, besides, residue, *etc.* The storage loss/gain is a very sensitive issue as it mainly depends upon agro climatic conditions. In order to minimize the losses during storage it is important to know the optimum environment conditions for storage of the product, as well as the conditions under which insects/pests damage the produce.

According to FAO study, about 70 per cent of the farm produce is stored by the farmers for their own consumption, seed, feed and other purposes in India. Farmers store grain in bulk using different types of storage structure made from locally available materials. For better storage, it is necessary to clean and dry the grain

to increase its life during storage. Storage structure, its design and construction play a strong role in reducing the crop losses during storage. Along with the storage structure, it is essential to ensure that the grain being stored is of good quality. At the village household level, crops are harvested with high moisture content and therefore before storing the same, it is necessary to bring down the moisture content to the desired level for storage. There are conventional type of storage structure at the farmer level for storage of food grains. Generally, the storage structures are constructed in rural areas with mud, bamboo, stone and plant materials. These are neither rodent proof, nor secure from fungal and insect attack. On an average, out of a total of 6 per cent loss of food grains in such storage structures, about 3 per cent is due to rodents and rest is due to insects and fungi. The other type of storage structures includes: coal tar drum bin, domestic Hapur bin, Chittore stone bin, double- walled polyethylene lined bamboo bin, Pusa bin and so on. The bulk storage of food grains is done mainly by traders, cooperatives and Government agencies like FCI, CWC, SWC and grain marketing cooperatives. There are several other storage systems followed by the farmers / market players depending on the period of storage and the products to be stored e.g. cover and plinth storage, community storage structures, rural godowns and scientific warehouses.

1.4 Need for the Study

As per the available data, the crop losses caused by pests and diseases are huge. There are more than 80,000 plant diseases known worldwide. In facts all plants are vulnerable to attack by diseases. Crop plants are frequent victim and crop diseases result in enormous economic losses. The causative factors of crop losses are broadly classified into two - infectious (biotic factors) and non infectious (abiotic) factors. The biotic factors include all the infectious diseases, parasites, weeds, nematodes and even protozoa while abiotic factors includes all the unfavorable agro-climatic conditions that hinder the healthy growth of plants. To feed the growing population, it is imperative to reduce the crop losses both at pre harvest and the post harvest stages. But, the information on the crop loss at the farm level is very much limited. In addition to losses that occur during the growth period of the crop, there is a huge quantity of grains lost during the process of harvesting, threshing, transportation and storage. Therefore, the present study makes a comprehensive attempt to estimate the dimension of losses occurring during the pre and post harvest stages of two selected crops. The study estimates the yield losses due to pest and diseases in the crops

namely paddy and wheat. Generally, the animal pests (insects, mites, rodents, snails and birds), plant pathogens (bacteria, fungi, virus and nematodes) and weeds are collectively called as pests, which cause economic damage to crops. This broader definition of pests is followed in the present study for pre harvest losses. For estimating the post harvest losses, there is a need to know the extent of losses during storage under different agro-climatic conditions. The main causes of storage losses include sprouting, transpiration, respiration, rot due to mould and bacteria and attack by insects. Sprouting, transpiration and respiration are physiological activities that depend on the storage environment (mainly temperature and relative humidity). These physiological changes affect the internal composition of the grains and result in destruction of edible material and deterioration in nutritional quality. But it was difficult to measure the loss due to physiological changes at the farm level. Nevertheless, an attempt was also made to estimate such losses based on the visual observations and according to farmers' estimates.

Keeping in view of this importance of the subject, the objectives of the present study has been framed as under:

1.5 Objectives of the Study

1. To estimate the physical and financial losses caused by pests and diseases in paddy and wheat at farm level
2. To examine the measures of pest and disease management to reduce the crop loss due to pests and diseases at farm level.
3. To arrive at post harvest losses in paddy and wheat under different agro-climatic conditions.
4. To identify factors responsible for such losses and suggest ways and means to reduce the extent of losses in different operations in order to increase national productivity.

1.6 Data Base and Methodology

The study was based on the farm level data collected from the two major paddy growing and two wheat growing districts of the State from two agro climatic zones. In the present study, Sonitpur and Golaghat districts were selected from the North Bank Plain Zone and the Upper Brahmaputra Valley Zone, respectively. Similarly, for wheat, Morigaon district from the Central Brahmaputra Valley Zone and Borpeta district from the Lower Brahmaputra Valley Zone were selected. From each district, two villages, one nearby the market/mandi centre and one far off from

the market centre were selected for canvassing the questionnaire. A random sample of 30 farmers were selected randomly from each village and thus constituting a total sample of 120 farmers for each crop in the State. Distribution of the sample farmers crop wise across the farm size groups is presented in Table 1.15. Combing two crops, the total sample stood at 240. Of the total samples, 22.42 per cent belonged marginal size group, 52.92 per cent belonged to small size groups, 25.00 per cent belonged to medium size group and 1.67 per cent belonged to large size group. In addition, visits were also made to the sample District Office of the Department of Agriculture, Government of Assam to collect relevant information for the study and Agriculture year 2011-12 (July to June) was taken as the reference year both the crops.

Table - 1.15
Distribution of sample farmers according to crops, districts and farm size groups

Crops and districts	Marginal	Small	Medium	Large	Total
Paddy crop					
Golaghat district	8	27	23	2	60
Sonitpur district	21	30	9	0	60
Wheat crop					
Morigaon district	8	34	16	2	60
Borpeta district	12	36	12	0	60
Total	49	127	60	4	240
Percentage	20.42	52.92	25.00	1.67	100.00

Source : Based on primary data.

1.7 Organization of the report

This study was proposed to be carried out in eight states of India *viz.*, Karnataka, West Bengal, Uttar Pradesh, Punjab, Madhya Pradesh, Tamil Nadu, Assam and Gujarat. The study is coordinated by the ADRTC, Banglore. The study is organized as per guidelines developed by the coordinating centre. In view of the objectives, the study was divided into 5 major chapters. Each chapter is further divided into some sub sections. As a whole the organization of the study is framed as follows:

Chapter-I

Introduction

1.1 Status of Agricultural Economy in the State, 1.2 Importance of Selected Crops in the State, 1.3 Back ground of Pre and Post Harvest losses, 1.4 Objectives of the Study, 1.5 Data base, and Methodology,1.6 Need for the Present Study

Chapter-II

(Area, Production and Productivity of Selected Crops in the state)

2.1 Trend and growth in area, production and yield of selected crops in the state, 2.2 Changes in costs and profitability of selected crops in the state,2.3 Secondary estimates of losses caused by pests and diseases of selected crops: A Review,2.4 Summary of the chapter

Chapter-III

Household Characteristics, Cropping Pattern and Production Structure

3.1 Socio – economic characteristics of the selected farmers, 3.2 Characteristics of operational holdings,3.3 Structure of tenancy,3.4 Sources of irrigation,3.5 Cropping pattern, 3.6 Percentage of area under HYV, 3.7 Crop productivity, marketed surplus and value of output by farm size, 3.8 Summary of the Chapter

Chapter-IV

Assessment of Pre Harvest Losses of Reference Crops

4.1 Constraints faced in cultivation of reference crops,4.2 Assessment of incidences of pests and disease attacks and crop losses,4.3 Methods of pests and diseases control adopted by the selected sample households,4.4 Sources of information for pests and disease control by the selected households,4.5 Household suggestions on how to minimize pre harvest losses,4.6 Summary of the chapter

Chapter-V

Assessment of Post Harvest Losses of Reference Crops

5.1 Production loss during harvest, 5.2 Production loss during threshing and winnowing ,5.3 Production loss during transportation and handling,5.4 Production loss during storage,5.5 Capacity utilization of storage by the selected households,5.6 Quantitative aspects of storage and their pests control measures adopted by the selected households,5.7 Households suggestions how to minimize post harvest losses, 5.8 Summary of thee Chapter

Chapter-VI

Concluding remarks and policy suggestion

References

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Chapter II

Area, Production and Productivity of Selected Crops in the State

2.1 Trend of growth in area, production and productivity of paddy and wheat

In this chapter, the growth trend in area, production and productivity of paddy (in terms of rice) and wheat was studied in the state of Assam during 2000-01 to 2010-11. Paddy, the main crop of the state is cultivated in the state in three seasons *viz.* autumn, winter and summer.

Table 2.1 shows the growth performance of total rice in terms of area, production and productivity (combining autumn, summer and winter rice) and wheat in Assam during the period under consideration 2000-01 to 2010-11.The CGR of area under total grew at a negative rate of -4.94 per cent while production and productivity grew at the rate of 1.33 and 1.71 per cent per annum, respectively.

The negative growth of area in total rice may be attributed to fall of area in autumn paddy. It was reported that the magnitude of crop losses was maximum in case of autumn paddy due to pre monsoon shower at the time of harvesting although the cost of cultivation was reported to be lower as compared to winter and summer rice.

Table-2.1

The Compound growth rate of Area, Production and Yield of total Rice and Wheat during 2000-01 -2010-11

(Area in Lakh Ha., Production in Lakh Tonne, Yield in Kg. per Ha.)

Year	Total Rice			Wheat		
	A	P	Y	A	P	Y
2000-01	26.46	39.98	1531	0.70	0.86	1219
2001-02	25.36	38.54	1540	0.72	0.85	1181
2002-03	25.41	37.38	1491	0.69	0.78	1129
2003-04	25.30	38.81	1555	0.70	0.73	1046
2004-05	23.83	34.70	1475	0.64	0.68	1066
2005-06	24.20	35.52	1487	0.50	0.54	1076
2006-07	21.90	29.16	1349	0.60	0.67	1132
2007-08	23.24	33.19	1428	0.56	0.71	1263
2008-09	24.84	40.70	1638	0.50	0.65	1300
2009-10	25.30	44.08	1765	0.60	0.65	1087
2010-11	25.71	50.33	1983	0.45	0.56	1256
CGR	-0.43	1.33	1.71	-3.93	-3.43	0.61

Source: Statistical Hand Book of Assam,
Directorate of Economics and Statistics, Govt. of Assam

In case of wheat, both area and production had declined during 2000-01 to 2010-11.The CGR of area and production had shown declined at a rate of 3.93 and 3.43 per cent per annum. As reported, pest and disease infestation was very high in wheat due to climatic condition of the state. However, the yield of wheat showed a marginal positive growth of 0.61 per cent during the period. It might be due to quality of seeds along with better package of practices adopted by the farmers at the guidance of the technical persons of the Agriculture Department of the state.

2.2 Changes in costs and profitability of selected crops in the state (Based on CACP Report)

In Assam, the Cost of Cultivation Scheme covers only three crops *viz.* paddy, jute and mustard. Wheat is out of the purview of the Cost Scheme as it is not considered as main crops of the State. Hence, the changes in cost and profitability of wheat could not be incorporated here. Table-2.2 gives the per hectare cost of

Table - 2.2
Cost of cultivation of paddy based on various cost concept, Assam

(Rs./ha)

Year	Cost A_1	Cost A_2	Cost B_1	Cost B_2	Cost C_1	Cost C_2
1996-97	2831.02	3262.83	3430.84	5581.67	6466.02	8616.85
1997-98	3348.14	3647.11	4033.36	6418.22	7117.65	9502.50
1998-99	3419.88	3765.65	4049.00	6718.97	7300.09	9970.23
1999-00	4786.52	5079.31	5621.75	8479.03	9277.77	12135.06
2000-01	5283.52	5645.69	6071.02	8941.73	10084.07	12954.78
2001-02	5568.90	5978.79	6360.93	9416.08	10389.04	13444.19
2002-03	5041.51	5350.08	6103.29	8927.42	10282.77	13106.89
2003-04	5584.43	6029.35	6556.68	9657.59	11088.46	14189.36
2004-05	6052.90	6448.80	6963.70	9573.40	11454.60	14364.30
2005-06	5916.20	8236.90	7076.90	10138.60	12017.50	15079.20
2006-07	6328.83	6538.43	7477.58	10286.78	12350.03	15159.23
2007-08	6892.57	7388.27	7980.34	11610.20	13074.63	16704.49
2008-09*	8626.68	8890.14	10196.69	14875.45	16034.24	20713.00
2009-10*	9359.57	9792.43	10966.67	16122.01	17546.80	22702.13
CGR	**3.94**	**3.82**	**3.86**	**3.35**	**3.39**	**3.17**

Source: CACP Report

Note: * indicates that the estimates are provisional.
Cost A_1 = All actual expenses in cash and kind incurred in production by owner
Cost A_2 = Cost A_1 + Rent paid to leased-in land.
Cost B_1 = Cost A_1 + Interest on value of owned capital assets (excluding land).
Cost B_2 = Cost B_1 + Rental value of owned land (land revenue) + Rent paid for leased-in land.
Cost C = Cost B_1 + Imputed value of family labour
Cost C_2 = Cost B_2 + Imputed value of family labour

cultivation of paddy based on various cost concepts. During 1996-97, Cos A_1 was reported to be Rs.2831.02 per hectare and the corresponding figures for CostA2, B_1, B_2, C_1 & C_2 were Rs. 3262.83, Rs.3430.84, Rs. 5581.67, Rs.6466.02 and Rs.8616.85, respectively. In 2009-10, all the costs increased significantly over 1996-97. It can be

attributed to increase in capital investment, increase value of land and price hike of all other inputs. In the reference year, the cost A_1 worked out at Rs. 9359.57, A_2 at Rs.9792.43, B_1 at Rs.10966.67, B_2 at Rs.16122.01 C_1 at Rs. 17546.80 and C_2 at Rs. 22702.13. In 1996-97, A_2 cost was 50.46 per cent of C1 while it was 55.81 per cent of C_1 in 2009-10. Similarly, the cost A_2 was 37.87 per cent of Cost C_2 in 1996-97 and 43.13 per cent in 2009-10. The CGR of costs A_1, A_2, B_1, B_2, C_1 and C_2 grew at the rate of 3.94, 3.82, 3.86, 3.35, 3.39 and 3.17 per cent in cost, respectively during 1996-97-2009-10.

Table-2.3 depicts the profitability indicators of paddy cultivation in Assam. The yield of paddy per hectare increased from 21.01 quintal per hectare in 1996-97 to 25.83 quintal in 2009-10. The lowest yield rate of 16.71 quintal per hectare was recorded in the year 2006-07. It might be due to severe flood in the sample area during reference period. As per report of the Statistical Hand Book, Directorate of

Table - 2.3
Profitability indicators of Paddy in Assam

(Rs/ha)

Year	Yield (q/ha)	Price (Rs/ha)	Price/Q	By Product	Gross Returns	Variable Cost	Total cost	Returns Over Variable Cost (ROVC)	Net Returns	
									Current Prices	Constant Prices (1996-97)
1996-97	21.01	8659.21	412.15	391.26	9050.47	5565.53	8616.85	3484.94	433.62	433.62
1997-98	22.01	10424.05	473.61	468.90	10892.95	6144.12	9502.50	4748.83	1390.45	1210.25
1998-99	21.91	12102.77	552.39	463.88	12566.65	6384.62	9970.23	6182.03	2596.42	2240.39
1999-00	24.90	13431.21	539.41	557.53	13988.74	8033.34	12135.06	5955.40	1853.68	1892.49
2000-01	26.17	12104.46	462.53	635.47	12739.93	8897.53	12954.78	3842.40	-214.85	-247.94
2001-02	25.65	12084.45	471.13	702.80	12787.25	9168.02	13444.19	3619.23	-656.94	-641.50
2002-03	24.57	11654.62	474.34	646.47	12301.09	8714.78	13106.89	3586.31	-805.80	-802.38
2003-04	25.77	12361.86	479.70	746.85	13108.71	9614.11	14189.36	3494.60	-1080.65	-1063.60
2004-05	22.20	10932.20	492.44	714.70	11646.90	10068.17	14363.87	1578.73	-2716.97	-2634.35
2005-06	25.20	12737.90	505.47	900.60	13638.50	10313.39	15034.85	3325.11	-1396.35	-1353.59
2006-07	16.71	10957.21	655.73	718.10	11675.31	10652.29	15159.23	1023.02	-3483.92	-2698.62
2007-08	25.38	16429.65	647.35	1011.91	17441.56	11451.90	16704.49	5989.66	737.07	749.39
2008-09*	26.75	19406.77	725.49	1130.99	20537.76	13825.73	20713.00	6712.03	-175.24	-156.85
2009-10*	25.83	20445.60	791.54	1307.10	21752.70	15297.14	22702.13	6455.56	-949.43	-865.57
CGR	0.31	2.14	1.84	4.04	2.24	3.39	3.17	-0.44	-0.61	-0.86

Source: CACP Report

Economics and Statistics, Govt. of Assam, the flood affected cropped area was recorded at 10406 hectares. Crop area damaged due to draught like situation in the state during the referred year might also contribute towards fall in yield rate. The CGR of yield during the period grew at a lower rate of 0.31 per cent per annum. The price in terms of rupees per hectare had increased during the period from Rs.8659.21 to Rs. 20445.60 with a CGR of 2.14 per cent. Similarly, the absolute price of paddy per quintal had increased from Rs. 412.15 to 791.54 between the periods under

observation. There has been reports from many corners that the price received by the farmers Here, it would be worthwhile to mention here that there was always a hue and cry among the farmers were not at all remunerative due to increase in prices of all farm inputs. Thus there is a need for fixation of the price of the produces in each year on the basis of cost production. The programme of purchasing of paddy through FCI under the MSP scheme was implemented in the state from 2009-10 only.

The prices of by- product had grown at 4.04 per cent per annum during the reference period. The gross returns had increased from Rs. 9050.47 to Rs. 21752.70 per hectare registering a CGR of 2.24 per cent between the periods. The CGR of variable cost and total cost per hectare were recorded at 3.39 and 3.17 per cent, respectively. The rates of increase of both the costs were at higher level as compared to gross returns. The returns over variable cost had shown an increase from Rs 3484.94 to Rs. 6455.56 with a negative CGR of -0.44 per cent. The CGR of net returns grew at a negative rate of -0.61 and -0.86 per cent at current and constant prices, respectively. Thus in real terms, profitability of paddy production has become an issue of much concern. Under this situation, the measures for reduction of crop losses at pre and post harvest stages bear much significance in the interest of the farmers and the economy of the state at large.

2.3 Secondary estimates of losses caused by pests and diseases of selected crops: A Review:

As such no systematic study was conducted to estimate the crop losses due to pests and diseases in Assam. A pilot study was conducted in Jorhat and Morigaon by AERC, Jorhat in 2006 for estimation of seed, feed, and wastage ratio for major food-grains of Assam. For wastage part of the study, it covered only two crops *viz.* paddy and pulses. As per the report, in Jorhat district, out of the total of paddy production (398607.81 kg), the total wastage was 26754.07 Kg. On an average sizes of farms, the highest wastage was recorded in harvesting (4.42%) followed by storage (1.20%), transportation (0.39%), left in straw (0.26%), threshing and shattering (0.25%), wastage in home consumption (0.17%) and left for animal /poultry feed(0.01%).

In Morigaon districts, out of the total production of paddy (379591.13 kg), the total wastage was 25147.47 Kg. The highest wastage of paddy was reported in harvesting (4.30%), followed by transportation (0.41 %), storage (1.22%), left in

straw (0.26%), threshing and shattering (0.25%), wastage in home consumption (0.17%) and left for animal /poultry feed (0.01%).

Thus, the total wastage of paddy in Jorhat district was 6.71 per cent of the total production and it was 6.62 per cent in Morigaon District.

Also, the highest wastage was recorded in harvesting stage followed by seed storage, which reflect improper handling of the crops in the field, damages due to adverse weather conditions and defective storage structures. Delay in harvesting also lead to shattering of grains. As such the farmers are needed to be trained in proper methods of harvesting/threshing and post harvest management of crops, protection of grains from insect/pests attack and construction of scientific storage structures.

2.4 Summary of the chapter

This chapter visualizes the growth performance the two mandatory crops (rice and wheat) in terms of area, production and productivity along with ongoing changes in costs and profitability of the selected crops in the state (Based on CACP Report). Rice is the principal crop of Assam grown extensively in three seasons *viz.*, autumn, winter and summer. The growth performance of total rice in terms of area, production and productivity (combining autumn, summer and winter rice) and wheat in Assam during the period under consideration 2000-01 to 2010-11.The CGR of area under total rice grew at a negative rate of -4.94 per cent while production and productivity grew at the rate of 1.33 and 1.71 per cent per annum, respectively. The negative growth of area under total rice may be attributed to fall of area in autumn paddy. It was reported that the magnitude of crop losses was maximum in case of autumn paddy due to pre monsoon shower at the time of harvesting although the cost of cultivation was reported to be lower as compared to winter and summer rice.

In case of wheat, both area and production had declined at the rate of 3.93 and 3.43 per cent, respectively during 2000-01 to 2010-11. As reported, pest and disease infestation is very high in wheat due to climatic condition of the state. The yield showed a positive growth of 0.61 per cent per annum during the period under observation which could be attributed to adoption improve crops varieties.

In Assam, the Cost of Cultivation Scheme covers only three crops *viz.* paddy, Jute and Mustard. Wheat is not a principal crop of Assam as such it is out of the purview of the Cost Scheme in Assam. Hence, the CACP data could not be utilized to show the changes in cost and profitability of wheat. In the cost of paddy during 1996-97, A_1 was out at out at Rs 2831.02 per hectare , cost A_2 Rs. 3262.83/ha and cost B_1

3430.84 , cost B_2 Rs. 5581.67/ha., cost C_1 Rs.6466.02/ha and C_2 Rs.8616.85/ha. In 2009-10, all the costs increased significantly over 1996-97. It can be attributed to increase of capital investment, increased value of land and price hike of all other farm inputs. In the reference year, the cost A_1 was worked out at Rs. 9359.57, A_2 at Rs.9792.43, B_1 at Rs.10966.67, B_2 at Rs.16122.01, C_1 at Rs. 17546.80 and C_2 at Rs. 22702.13. In 1996-97, A2 cost was 50.46 per cent of C1 while it was 55.81 per cent of C_1 in 2009-10. Similarly, cost A_2 was 37.87 per cent of cost C_2 in 1996-97 and 43.13 per cent in 2009-10. The CGR grew at the rate of 3.94, 3.82, 3.86, 3.35, 3.39 and 3.17 per cent in respect of costs A_1, A_2, B_1, B_2, C_1 and C_2 cost, respectively during 1996-97-2009-10.

The yield rate of paddy per hectare increased from 22.01 quintal per hectare in 1996-97 to 25.83 quintal in 2009-10. The lowest yield rate 16.71 quintal per hectare was seen in the year 2006-07. It might be due to severe flood in the sample area. As per report of the Statistical Hand Book, Directorate of Economics and Statistics, Govt. of Assam, flood affected cropped area was recorded at 10,406 hectares. Crop area damaged due to draught like situation in the state during the referred year might also be another the causes of fall in yield rate The CGR of yield during the period grew at a lower rate of 0.31 per cent per annum. The yield rate per hectare in terms of rupees had increased during the period from Rs.8659.21 to Rs. 20445.60 with a CGR of 2.14 per cent. The price of paddy had shown an increasing trend from Rs. 412.15 to 791.54 between the periods under observation. There has been report, every now and then, that the prices received by the farmers are not at all remunerative due to increase in the prices of other farm inputs. The programme of purchasing of paddy through FCI under the MSP scheme has been implemented in the state only in 2009-10. The prices of by product had grown @ 4.04 per cent per annum during the reference period. The gross return had increased from Rs. 9050.47 to Rs. 21752.70 per hectare with the CGR of 2.24 per cent over the reference period. The CGR of variable cost and total cost per hectare were found at 3.39 and 3.17 per cent, respectively. Both were at higher rate as compared to that of gross returns. The returns over variable cost had shown an increase from Rs 3484.94 to Rs. 6455.56 with a negative CGR of -0.44 per cent which is a matter of concern for the state agriculture. The most significant observation was that the net return per hectare at current and constant prices had shown losses from 2000-01 onwards. The CGR of net returns grew at a negative rate of -0.61 and -0.86 per cent at current and constant prices,

respectively. Under the situation, urgent measures for reduction of crop losses during pre and post harvest stage deemed very important.

In Assam, there was no study conducted as such to estimate the crop losses caused by pests and diseases. However, a pilot study was conducted in Jorhat and Morigaon Districts of Assam by the AERC, Jorhat in 2006 for estimation of seed, feed, and wastage ratio for major food-grains of Assam. For wastage part of the study, it covered only two crops *viz*. paddy and pulses. As per findings of the report, in Jorhat district, out of the total production of paddy (398607.81 kg), the total wastage was 26754.07 Kg. On an average (all sizes of farms) highest wastage of paddy was witnessed in harvesting (4.42%), followed by storage (1.20%), transportation (0.39), left as straw (0.26%), threshing and shattering (0.25%), wastage in home consumption (0.17%), left for animal /poultry feed (0.01%).

In Morigaon district, out of the total production of paddy (379591.13 kg), the total wastage was 25147.47 Kg. The highest wastage of paddy was seen in harvesting (4.30%), followed by transportation (0.41%), storage (1.22%), left in straw (0.26%), threshing and shattering (0.25%), wastage in home consumption (0.17%), left for animal / poultry feed (0.01%).

The total wastage of paddy was 6.71 per cent of total production in Jorhat and it was 6.62 per cent in Morigaon District. The highest wastage was witnessed in harvesting followed by seed storage, which reflect improper handling of crops in the field and defective storage structures. Delay in harvesting also lead to shattering of grains. Therefore, the farmers are needed to be trained in proper methods of harvesting/ threshing and post harvest management of crops including protection of grains from insect/pests attack and construction of scientific storage structures.

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Chapter III

Household Characteristics, Cropping Pattern and Production Structure

3.1 Socio-economic characteristics of selected farmers

This chapter deals with the households characteristics, cropping pattern and production structure of the sample households.

The demographic profile is considered to be an important indicator to gather to have an over-view of the socio-economic conditions of the people living in a particular area. An attempt has been made here to focus on the socio-economic characteristics of the selected sample farmers.Table-3.1 gives the demographic profile of the sample farmers of 240 households across the farm size groups in terms of percentages. The highest percentage (52.92%) of households was found in small size group followed by medium (25.00%), marginal (20.42%) and large size group (1.67%). Average household size across all the farm size groups was 6.09 in which the highest household size of 6.75 was found against the large farm size group and the lowest (5.51%) was found against the marginal size group of farms. Average number of earner per household was 1.70. The overall male population was 42.98 per cent and female population was 35.52 per cent of the total sample population 1,461. The aggregate children population less than 15 years was 21.49 per cent. The identity of the respondents was categorized into Head and Others. Head indicates head of the family and Others indicate any adult family member with the ability to provide required information other than Head. Of the total sample households, 70 per cent respondents were Head and 30 per cent were found under others category. On an average 4.58 per cent respondents belonged to the age in the age less than 25 years, 33.33 per cent were between the age group of 25 to 40 years and 62.08 per cent in the age group above 40 years. Educational status is an important socio-economic indicator of a family. The status was determined on the basis of the highest educational qualification of the family member of the households. On scrutiny, 7.92 per cent of family member was found as illiterate, 29.17 per cent read up to primary level, 33.75 per cent read up to Secondary level, 20.33 per cent read up to Higher Secondary level and 9.17 per cent were found to have education up to graduate and

above. As there is a distinct variation of social characteristics among the different social groups, while surveying, an effort was also made to capture the cast structure of the sample households. The sample population was dominated by the general cast people (54.17%) followed by SC (21.67%) ,ST (12.50%) and OBC (11.67%).

Table- 3.1
Demographic profile of the selected farmers (% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No of HH		20.42	52.92	25.00	1.67	100.00
Household size (numbers)		5.51	6.19	6.30	6.75	6.09
Average numbers of earners		1.49	1.76	1.75	1.75	1.70
Proportion of Male/ Female/ Children (%)	Male >15	43.70	41.60	45.77	37.04	42.98
	Female >15	38.89	34.99	34.39	33.33	35.52
	Children <15	17.41	23.41	19.84	29.63	21.49
Identity of respondent (%)	Head	59.18	71.65	75.00	75.00	70.00
	Others	40.82	28.35	25.00	25.00	30.00
Average age of the respondent (% households)	Less than 25	8.16	3.94	3.33	0.00	4.58
	Between 25 to 40	16.33	29.92	56.67	0.00	33.33
	Above 40	75.51	66.14	40.00	100.00	62.08
Highest Education status of a family member (% households)	Illiterate	14.29	5.51	8.33	0.00	7.92
	Up to primary	24.49	22.83	48.33	0.00	29.17
	Up to secondary	28.57	40.16	20.00	100.00	33.75
	Higher secondary	28.57	16.54	21.67	0.00	20.33
	Graduate and above	4.08	14.96	1.67	0.00	9.17
Caste (% households)	SC	34.69	22.05	11.67	0.00	21.67
	ST	4.08	9.45	23.33	50.00	12.50
	OBC	14.29	11.02	11.67	0.00	11.67
	General	46.94	57.48	53.33	50.00	54.17
Distance from the main market (km)		6.45	7.41	7.64	6.75	7.26
Annual family income (Rs)		75,796	84,795	90,797	184,000	86,112

Source: Based on primary data

The higher transportation cost and amount of loss in transit usually reduce the farmer's profit if the main market is located at far off place. In the sample area the main market was found to be at at an average distance of 7.26 Km.

The average annual income per farm family from all sources of economic activities stood at Rs.86, 112. The family income was found to increase with farm size i.e., from marginal to large size group of farm households.

3.2 Characteristics of operational holdings

Farm size wise operational holdings and cropping intensity of the sample area are presented in Table-3.2. The average size of holding of owned land, uncultivated land, leased in land,, leased out land, net operated area (NOA), irrigated area and gross cropped area were found at 1.76 , 0.17, 0.15, 0.12 , 1.61,0.17 and 2.53 hectares per household, respectively. It has been observed that all the farm size groups had

land under leased in and leased out land. Scattered distribution of land was the main reason behind of these two types of holdings. Exchanges of land among the farmers were also another practice pursued in the locality for economic use of land. Cropping intensity was found to increase from large size group (130%) to marginal size group (173%) and on an average; it stood at 157 per cent which was higher than the state average (146%) in 2010-11. It might be because of the fact that the area sown more than once was on the higher side groups among the smaller size groups compared to large size group It can be attributed to increase in area under vegetables and summer paddy.

Table: 3.2
Size of operational holdings (hectares per household)

Farm size	Owned land	Un cultivated land	Leased-in	Leased-out	NOA	Irrigated area	GCA	Cropping Intensity(%)
Marginal	0.80	0.13	0.08	0.02	0.72	0.13	1.25	173
Small	1.42	0.15	0.20	0.05	1.43	0.15	2.39	167
Medium	2.96	0.25	0.08	0.31	2.48	0.25	3.58	144
Large	6.06	0.27	0.00	0.60	5.19	0.27	6.73	130
Total	1.76	0.17	0.15	0.12	1.61	0.17	2.53	157

Note: Net operated area (NOA)

3.3 Structure of tenancy

In the state, the tenancy system of cultivated land is of two types-crop sharing (50:50) and rental system of land. Rent of the rental land is not fixed and it varies from region to region depending upon soil fertility, location and facilities of irrigation. Rent is higher in irrigated area. In vegetables growing areas, the rent of the land is much higher for up land area than the medium and low land. Similarly rental value of high cropping intensity area is usually higher than the area with low cropping intensity. Table 3.3 gives the nature of tenancy in leased-in and leased-out land across the farm size groups in terms of percentage of households. In case of leased in land crop sharing was practised by 18.37 and 37.01 per cent of marginal and small size groups, respectively. In aggregate, it stood at 23.33 per cent. There was none among the sample farmers practising crop and cost sharing together. However, the nature of tenancy in leased-in land was 50:50 share of the total production. Only 5 households (8.33%) had agreed on fixed rent in case of leased in land. The overall, the nature of tenancy in-leasing in land combining both the agreement stood at 25.42 per cent out of the 240 sample households. The total share of tenancy to net cropped area was 8.77 per cent. The overall rent amount in case of leased in- land was of Rs.6, 800.00 per hectare per annum. In case of leased out land, there was no report on crop sharing and crop & cost sharing together. But the practice of fixed rent in cash was found in all the

farm size groups. Of the total sample households, 16.67 per cent of households had accepted the fixed rent in cash. The rent amount varied between Rs.6, 800.00 (small size group) and Rs.7,500.00 (medium size group) with an average of Rs.7, 125.00 per hectare per annum.

Table-3.3
Nature of tenancy in leased-in/leased-out land (% households)

Farm size	Crop sharing	Crop and cost sharing	Fixed rent in cash	Others	Total	% share of tenancy in NOA	Rent amount Rs. Per hectare.
(Leasing-in)							
Marginal	18.37 (9)	0.00	0.00	0.00	18.37 (9)	11.36	0.00
Small	37.01 (47)	0.00	0.00	0.00	37.01 (47)	14.30	0.00
Medium	0.00	0.00	8.33 (5)	0.00	8.33 (5)	3.24	6800.00
Large	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	23.33 (56)	0.00	2.08 (5)	0.00	25.42 (61)	8.77	6800.00
(Leasing-out)							
Marginal	0.00	0.00	6.122 (3)	0.00	6.12(3)	3.36	7200.00
Small	0.00	0.00	9.45 (12)	0.00	9.45(12)	3.72	6800.00
Medium	0.00	0.00	38.33 (23)	0.00	38.33(23)	12.31	7500.00
Large	0.00	0.00	50.00 (2)	0.00	50.00(2)	11.61	7000.00
Total	0.00	0.00	16.67 (40)	0.00	16.67(40)	7.23	7125.00

N0te: Figures in parentheses indicate number of households

3.4 Sources of irrigation

In the sample area, the diesel tube well was the only source of irrigation in all the farm size groups. In terms of percentage, the highest irrigated area (45.08%) was found in small size group followed by medium (36.44 %), marginal (15.88%) and large size group (2.60%) (Table-3.4).

Table: 3. 4
Source wise irrigation of net irrigated area (%)

Farm size	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Others
Marginal	0.00	0.00	0.00	15.88	0.00	0.00	0.00
Small	0.00	0.00	0.00	45.08	0.00	0.00	0.00
Medium	0.00	0.00	0.00	36.44	0.00	0.00	0.00
Large	0.00	0.00	0.00	2.60	0.00	0.00	0.00
Total	0.00	0.00	0.00	100.00	0.00	0.00	0.00

Source: Primary data

3.5 Cropping pattern

Irrigation and seed variety are the two key factors which can change the cropping pattern of a particular area. Food habits of the people also bear significant in determining the cropping pattern of a state. The crop season of the state is basically divided into two main seasons-*Kharif* from April to September and *Rabi* from October to March. Rice is the principal crop of the state. *Kharif* paddy occupied maximum area under the gross cropped area across the farm size groups. The maximum area under HYV (57.01%) was recorded in medium size group followed

by large (54.21%), small (49.75%) and marginal (45.13%) size group with an average of 51.98 per cent of the total gross cropped area. The highest area under local paddy (22.88 %) was found against large size group and the lowest (7.49%) in marginal size group with an average of 11.27 per cent of the gross cropped area. Maximum (2.65%) area under *Kharif* vegetables was found in large farm size group followed by marginal (2.28%), small (1.37 %) and medium size group (0.84%).

In *Rabi* season, wheat was the dominant crop for small (10.34%), marginal (10.00%) and large size group (3.98 %) as compared to area under pulses and vegetables. No area was found under pulses in marginal size group and the highest 1.49 per cent area was found in large farm size group. The overall area stood at 8.28, 1.02 and 8.67 per cent for wheat, pulses and vegetables, respectively.

The percentage distribution of summer paddy area was found at 18.72, 13.73, 10.73 and 9.45 per cent, respectively for marginal, small, medium and large farm size group. On an average, it stood at 13.04 per cent of the gross cropped area. The area under sugarcane was found only in small (1.08 %) and medium (1.09 %) size groups constituting 0.91 per cent of the GCA. The area under horticultural crop was found to decline from marginal to large size group. The average area under the horticultural crops stood at 3.47 per cent. The details are presented in Table -3.5.

Table -3.5
Cropping pattern of selected farmers

(% of GCA for the whole year)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Paddy HYV	45.13	49.76	57.01	54.21	51.98
Paddy Local	7.49	10.11	12.66	22.88	11.27
Vegetables	2.28	1.37	0.84	2.65	1.34
Rabi crops					
Wheat	10.34	10.00	5.74	3.98	8.28
Pulses	0.00	1.24	0.98	1.49	1.02
Vegetables	9.73	8.96	8.52	3.86	8.67
Summer crops					
Paddy HYV	18.72	13.73	10.73	9.45	13.04
Perennial crops					
Sugarcane	0.00	1.08	1.09	0.00	0.91
Horticulture crop	6.30	3.75	2.43	1.49	3.47
Gross cropped area	61.34	303.23	214.59	28.91	608.07
Percentage total	100.00	100.00	100.00	100.00	100.00

Source: Primary Data

Note : Kharif vegetables includes Ridge gourd, Bitter gourd,Bottle gourd, Okra, Spike gourd, White gourd, Pumpkin, Water Pumpkin , Red pumpkin,Chilli,etc.
Rabi vegetables includes Cabbage, Knol Khol, Cauliflower, tomato, brinjal and leafy vegetables

3.6 Percentage of area under HYV seeds

Table-3.6 shows the area under HYV seeds of the different crops grown in the sample area. Most of the area under different crops was covered by HYV seeds and the percentage of area under HYV seeds in *Kharif* paddy stood at 82.14 per cent.

Table- 3.6
Percentage of area under HYV seeds

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Paddy HYV	85.78	83.11	81.82	70.31	82.14
Vegetables	100.00	100.00	100.00	100.00	100.00
Rabi crops					
Wheat	100.00	100.00	100.00	100.00	100.00
Pulses	0.00	100.00	100.00	100.00	100.00
Vegetables	100.00	100.00	100.00	100.00	100.00
Summer crops					
Paddy HYV	100.00	100.00	100.00	100.00	100.00

Source: Primary level data

3.7 Crop productivity

Table 3.7 gives the productivity of crops grown in different seasons along with the Perennial crops in the sample area across the farm size groups. *Kharif* paddy (local & HYV) had shown a decreasing trend in yield with farm size, registering an overall productivity of 32.83 quintal per hectare for HYV paddy and 27.79 quintal per hectare for local paddy. In case of *Kharif* vegetables, the highest productivity of 170.24 per hectare was found by the medium size group and the lowest (147.96 quintal) by the small size group. The overall yield stood at 153.57 kg per hectare.

Table- 3.7
Average yield of major crops grown by the selected households

(Quintal per hectare)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Paddy HYV	35.86	33.50	31.61	29.73	32.83
Paddy Local	27.29	28.96	26.77	26.89	27.79
Vegetables	147.96	138.38	170.24	157.72	153.57
Rabi crops					
Wheat	18.48	18.35	18.25	14.94	18.27
Pulses	0	9.56	9.89	10.8	10.08
Vegetables	151.29	175.65	185.57	204.28	179.20
Summer crops					
Paddy HYV	45.15	44.55	41.56	37.08	43.55
Perennial crops					
Sugarcane	0	39,800	41,600	0	40,700
Arecanut	67,000	72,000	63,000	59,400	65,350
Coconut	8,250	7,380	7,860	6,950	7,610

Note: (1) Nuts per bearing tree.
(2) Yield of vegetables in Quintals.
(3) No. of canes/ha.

The overall productivity of wheat and pulses stood at 18.27 quintal and 10.08 quintal per hectare, respectively. Per hectare return from *rabi* vegetables was higher than that of *Kharif* vegetables. The highest per hectare yield (204.28quintal) was found in large farm size group followed by medium (185.57 quintal), small (175.65quintal) and marginal (151.29 quintal) size group with an average return of 179.20 quintal/ha.

The productivity of summer paddy is usually more than that of the *kharif* paddy. The overall productivity in the study area was found at 43.55 quintal per hectare.

During the field study, productivity of 3 perennial crops *viz.,* sugarcane, arecanut and coconut was also recorded. Sugarcane cultivation was found in small and medium size group only. On an average, productivity of sugarcane stood at 40,700 numbers (cane) per hectare. In case of arecanut and coconut, the overall yield rate stood at 65,350 and 7,610 numbers per hectare, respectively.

3.8 Summary of the chapter

This chapter deals with the households characteristics, cropping pattern and production structure of the sample households.

The demographic profile in this study covered 240 sample households across four different size groups. The highest number (52.92%) of households was found in small size group followed by medium (25.00%), marginal (20.42%) and large size group (1.67%). Average household size across all the farm size groups was 6.09 and it was found to increase with farm size, from marginal category onwards. Average number of earner per household was 1.70. The overall male population was 42.98 per cent and female population was 35.52 per cent of the total sample population (1,461). Identity of the respondents was categorized into Head and Others. Head indicates head of the family and others indicates any adult family member, other than Head with the ability to provide required information during the survey. Of the total sample households, 70 per cent respondent were Head and 30 per cent found under others category. On an average, 4.58 per cent belonged to the category to the age less than 25 years, 33.30 per cent were between the age group 25 to 40 years and 62.08 per cent were in the age group above 40 years. Educational status is a major socio-economic indicator of a family. On an average, 7.92 per cent of the family members were found as illiterate, 29.17 per cent read up to primary level, 33.75 per cent read up to Secondary level,20.33 per cent read up to Higher Secondary level ,9.17 per cent were found to have education up to graduate and above. Caste-wise, the sample population was dominated by the general category (54.17%) followed by SC (21.67%), ST (12.50%) belonged to ST and OBC (11.67%) category. The higher

transportation cost and amount of loss in transit usually reduce farmer's profit if main market is located at far off places. The main market in the sample area is located at an average distance of 7.26 km from the farm households.

The average annual income per farm family from all sources of economic activities stood at Rs.86, 112. Family income showed an increasing trend with farm size from marginal size group onwards.

The average size of holding of owned land, uncultivated land, leased in land , leased out land net operated area (NOA), irrigated area and gross cropped area were found at 1.76 , 0.17, 0.15, 0.12 , 1.61,0.17 and 2.53 hectares per household, respectively. It has been observed that all the farm size groups had land under leased in and leased out category as well. Scattered distribution of land was the main reason behind of these two types of holdings. Exchange of land among the farmers for economic use was also observed in the locality. Cropping intensity was found to increase from large size group (130%) to marginal size group (173%) and on an average; it stood at 157 per cent which was higher than the state average (146%) in 2010-11. It might be because of the fact that the area sown more than once was on the higher side groups among the smaller size groups compared to large size group It can be attributed to increase in area under vegetables and summer paddy.

In the state, the tenancy system of cultivated land is of two types-crop sharing (50:50) and rental system of land. Rent of the rental land is not fixed and it varies from region to region depending upon soil fertility, location and facilities of irrigation. Rent is higher in irrigated area. In vegetables growing areas, the rent of the land is much higher for up land area than the medium and low land. Similarly rental value of high cropping intensity area is usually higher than the area with low cropping intensity. In case of leased in land crop sharing was practised by 18.37 and 37.01 per cent of marginal and small size groups, respectively. In aggregate, it stood at 23.33 per cent. There was none among the sample farmers practising crop and cost sharing together. However, the nature of tenancy in leased-in land was 50:50 share of the total production. Only 5 households (8.33%) had agreed on fixed rent in case of leased in land. The overall, the nature of tenancy in-leasing in land combining both the agreement stood at 25.42 per cent out of the 240 sample households. The total share of tenancy to net cropped area was 8.77 per cent. The overall rent amount in case of leased in- land was of Rs.6, 800.00 per hectare per annum. In case of leased out land, there was no report on crop sharing and crop & cost sharing together. But the practice

of fixed rent in cash was found in all the farm size groups. Of the total sample households, 16.67 per cent of households had accepted the fixed rent in cash. The rent amount varied between Rs.6,800.00 (small size group) and Rs.7,500.00 (medium size group) with an average of Rs.7, 125.00 per hectare per annum.

In the sample area, the diesel tube well was the only source of irrigation in all the farm size groups. In terms of percentage, the highest irrigated area (45.08%) was found in small size group followed by medium (36.44 %), marginal (15.88%) and large size group (2.60%) (Table-3.4).

Irrigation and seed variety are the two key factors which can change the cropping pattern of a particular area. Food habits of the people also bear much significant in determining the cropping pattern of a state. T he policy of the Government also matters in changing the cropping patterns. The crop season of the state is basically divided into two main seasons-*Kharif* from April to September and *Rabi* from October to March. Rice is the principal crop of the state. *Kharif* paddy occupied maximum area under the gross cropped area across the farm size groups. The maximum area under HYV (57.01%) was recorded in medium size group followed by large (54.21%), small (49.75%) and marginal (45.13%) size group with an average of 51.98 per cent of the total gross cropped area. The highest area under local paddy (22.88 %) was found against large size group and the lowest (7.49%) in marginal size group with an average of 11.27 per cent of the gross cropped area. Maximum (2.65%) area under *Kharif vegetables*, was found in large farm size group followed by marginal (2.28%), small (1.37 %) and medium size group (0.84%).

In *Rabi* season, wheat was the dominant crop for small (10.34%), marginal (10.00%) and large size group (3.98 %) as compared to area under pulses and vegetables. No area was found under pulses in marginal size group and the highest 1.49 per cent area was found in large farm size group. The overall area stood at 8.28, 1.02 and 8.67 per cent for wheat, pulses and vegetables, respectively.

The percentage distribution of summer paddy area was found at 18.72, 13.73, 10.73 and 9.45 per cent, respectively for marginal, small, medium and large farm size group. On an average, it stood at 13.04 per cent of the gross cropped area.

Sugarcane was found only in small (1.08 %) and medium (1.09 %) size groups constituting 0.91 per cent of the GCA. The area under horticultural crops was found increase continuously from marginal to large size group. The overall area horticultural crops stood at 3.47 per cent.

Most of the area under different crops covered by HYV seeds and the percentage area under *Kharif* paddy were recorded at 82.14 per cent.

Kharif paddy (local & HYV) had shown a decreasing trend in yield with farm size, registering an overall productivity of 32.83 quintal per hectare for HYV paddy and 27.79 quintal per hectare for local paddy. In case of *Kharif* vegetables, the highest productivity of 170.24 per hectare was found by the medium size group and the lowest (147.96 quintal) by the small size group. The overall yield stood at 153.57 kg per hectare.

The overall productivity of wheat and pulses stood at 18.27 quintal and 10.08 quintal per hectare, respectively. Per hectare return from *rabi* vegetables was higher than that of *Kharif* vegetables.

Per hectare return from *rabi* vegetables was higher than that of *Kharif* vegetables. The highest per hectare yield (204.28 quintal) was found in large farm size group followed by medium (185.57 quintal), small (175.65 quintal) and marginal (151.29 quintal) size group with an average return of 179.20 quintal/ha.

The productivity of summer paddy is usually more than that of the *kharif* paddy. The overall productivity in the study area was found at 43.55 quintal per hectare.

During the field study, productivity of 3 perennial crops *viz.*, sugarcane, arecanut and coconut was also recorded. Sugarcane cultivation was found in small and medium size group only. On an average, productivity of sugarcane stood at 40,700 numbers (cane) per hectare. In case of arecanut and coconut, the overall yield rate stood at 65,350 and 7,610 numbers per hectare, respectively.

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Chapter IV

Assessment of Pre Harvest Losses of Reference Crops

4.1 Constraints faced in cultivation of reference crops – Paddy and Wheat

This chapter has been designed to assess of pre harvest losses of paddy and wheat and also to ascertain the kind of constraints faced by the farmers.

Table 4.1 gives the opinion of the sample households on the different constraints faced in cultivation of the referred crops under study. Severity of the constraints was measured in terms of the percentages of households to the total sample households. Here crop-I and crop-II indicates paddy and wheat, respectively. In case of crop-I, 92.50 per cent of the total sample households (120), opined that low output price was the most important constraint for them while in case of crop-II, 65.00 per cent of the total sample households considered it to be the most important constraints. In case of pests and diseases, 23.33 per cent for crop-I and 90.83 for Crop-II per cent of the households opined as the most important constraint for them. For crop-I, 69.17 per cent of households opined that the high cost of inputs was the most important constraint for them and it was 87.50 per cent for crop-II. The most

Table-4.1
Constraints faced in cultivation of reference crop

(Percentage of households)

Sl. No.	Constraints Faced	Crop – I (Paddy)				Crop –II (Wheat)			
		Most important	Important	Least important	Total	Most important	Important	Least important	Total
1	Poor seed quality	33 (27.50)	42 (35.00)	45 (37.50)	120 (100.00)	77 (58.33)	23 (25.00)	20 (16.67)	120 (100.00)
2	Water deficiency	19 (52.50)	63 (15.83)	38 (31.67)	120 (100.00)	81 (67.50)	11 (9.17)	28 (23.33)	120 (100.00)
3	Pest and disease problems	28 (23.33)	59 (49.17)	33 (27.50)	120 (100.00)	23 (90.83)	41 (6.67)	56 (2.50)	120 (100.00)
4	High cost of inputs	83 (69.17)	37 (30.83)	0 (0.00)	120 (100.00)	69 (87.50)	27 (7.50)	24 (5.00)	120 (100.00)
5	Low output price	111 (92.50)	7 (5.83)	2 (1.67)	120 (100.00)	78 (65.00)	22 (18.33)	20 (16.67)	120 (100.00

Note: Parentheses figures indicate percentages.
Source: Primary data

important constraint as reported by 52.50 per cent households in case of crop-I was water deficiency and 67.50 per cent considered it to be the most important for Crop-II. The poor seed quality was the most important constraints as identified by the 27.50 and 58.33 per cent of households for crop-I and crop-II, respectively.

4.2 Assessment of incidences of pests and disease attacks and crop losses

Crop damage by pests and diseases in the farmer's field was usually detected by the farmers on visual observation. Most of the farmers rarely could identify the symptoms of pests and diseases in the early stage of attack. They mostly depended upon the village extension workers or other technical officers fro the District Agricultural Office. However, in the later stage of pest and disease infestations, a large percentage of the farmers acquired adequate knowledge on the symptoms of pest and diseases. But they had never done any quantitative assessment of the attack. Table-4.2a gives the views of the farmers in identification of pests and diseases attack in terms percentage of households. For crop-I, 60 per cent of the households could distinguish pest and disease attack from their past experience of knowledge and it was 53.33 per cent for Crop-II. The same percentages of households had reported to have done qualitative assessment about the severity of the attack for both the crops.

Table - 4.2a
Identification of pests and disease attack

(percentage of households)

Description		Crop - I	Crop - II
HH able to distinguish pests and disease attack		60.00	53.33
Assessment about the severity of the attack	Quantitative assessment	0.00	0.00
	Qualitative assessment	60.00	53.33
	Both	0.00	0.00

Source: Primary data

Table-4.2b gives the incidence of major pests, diseases and weeds of local and HYV paddy, frequency of attack and production losses on the basis of the observation made by the respondents in terms percentage to the total respondents (120). The farmers also had different opinions on severity of incidence of attacks which were influenced by the type of seeds used, fertilizer and FYM used, topography of the land, soil fertility, water level of the field, intensity of rainfall, sun shine hours, etc. They cited an example that the weed infestation is very high in high land as compared to medium and low land. Similarly, growth of the crops is generally high when fertilizer is applied and crop plants become creating a favorable environment for pests and diseases. That was why; there was a variation of opinions among the respondent.

Rank of severity of attack was measured by three different opinions as expressed by the farmers- rank 1 stood for very important, rank 2 stood for important and rank 3 stood for not important. There were 4 major pests for paddy *viz.* paddy stem borer, *gandhi* bug, Rice hispa and Green leaf hopper. Production losses due to attack of pests and diseases was measured in terms percentage (given in the table below) as reported by the respondents.

In local paddy, the rank of severity of stem borer was 1, i.e., very important as reported by 51.67 per cent households, 40.00 per cent reported as important(2) while 8.33 per cent found it to be not important (3). The frequency of attack of stem borer was reported in every season by 100 per cent respondents. The intensity of production losses due to attack of insects were measured in terms the percentage of sample households in 5 categories numbered from 1 to 5, where loss 1 stands for less than 5 per cent, loss 2 between 5 to 10 per cent , loss 3 between 10 to 25 per cent, loss 4 between 25 to 50 per cent and loss 5 lies above 50 per cent. The intensity of production losses due to attack of stem borer was found to be less than 5 per cent and was reported by 20.00 per cent households, 5 to 10 per cent loss was reported by 32.50 per cent of households and 10 to 25 per cent loss was reported by 47.50 per cent respondents.

The rank of severity of *gandhi* bug was 1(very important) reported by 49.17 per cent respondents, 29.17 per cent reported as important while 21.67 per cent reported as not important. The frequency of attack of Gandhi bug was reported in every season by 100 per cent respondents and there was no report of attack under two other situations. Production loss due to the attack of Gandhi bug was less than 5 per cent as reported by 17.50 percent households, 5 to 10 per cent loss was reported by 40.83 per cent households, 10 to 25 per cent loss was reported by 38.33 per cent households and 25 to 50 per cent loss was reported by 3.33 per cent respondents.

The severity of rice hispa was ranked as very important (rank 1) by 37.50 per cent respondents, 50.83 per cent reported it to be important (rank 2) while 11.67 per cent reported as not important (rank 3). The frequency of attack of rice hispa was reported in every season by 100 per cent respondents. Production loss due to the attack of rice hispa was less than 5 per cent as reported by 15.00 per cent households, 5 to 10 per cent loss was reported by 29.17 per cent households, 10 to 25 per cent loss was reported by 49.17 per cent households and 25 to 50 per cent loss was reported by 6.67 per cent respondents.

The rank of severity against green leaf hopper was considered to be very important(Rank 1) and was reported by 26.67 per cent of the respondent, 19.17 per cent reported as important (rank 2) while 54.17 per cent reported as not so important(rank 3). The frequency of attack of green leaf hopper was reported in every season by 100 per cent respondents. Production loss due to the attack of green leaf hopper was less than 5 per cent and was reported by 13.33 per cent, 5 to 10 per cent loss was reported by 66.67 per cent and 10 to 25 per cent loss was reported by 20.00 per cent respondents.

Table 4.2b
Incidence of major pests and disease - Crop I (Paddy)

Name of the pest/disease/weed	Rank of severity*			Frequency of attack**			Production loss***				
	1	2	3	1	2	3	1	2	3	4	5
Major Pests – Local variety											
Paddy stem borer	62 (51.67)	48 (40.00)	10 (8.33)	120 (100.00)	0 (0.00)	0 (0.00)	24 (20.00)	39 (32.50)	57 (47.50)	0 (0.00)	0 (0.00)
Gandhi bug	59 (49.17)	35 (29.17)	26 (21.67)	120 (100.00)	0 (0.00)	0 (0.00)	21 (17.50)	49 (40.83)	46 (38.33)	4 (3.33)	0 (0.00)
Rice hispa	45 (37.50)	61 (50.83)	14 (11.67)	120 (100.00)	0 (0.00)	0 (0.00)	18 (15.00)	35 (29.17)	59 (49.17)	8 (6.67)	0 (0.00)
Gren leaf hopper	32 (26.67)	23 (19.17)	65 (54.17)	120 (100.00)	0 (0.00)	0 (0.00)	16 (13.33)	80 (66.67)	24 (20.00)	0 (0.00)	0 (0.00)
Major Pests - HYV variety											
Paddy stem borer	68 (56.67)	40 (33.33)	12 (10.00)	120 (100.00)	0 (0.00)	0 (0.00)	8 (6.67)	42 (35.00)	70 (58.33)	0 (0.00)	0 (0.00)
Gandhibag	59 (49.17)	45 (37.50)	16 (13.33)	120 (100.00)	0 (0.00)	0 (0.00)	9 (7.50)	29 (24.17)	39 (32.50)	43 (35.83)	0 (0.00)
Rice hispa	62 (51.67)	54 (45.00)	4 (3.33)	120 (100.00)	0 (0.00)	0 (0.00)	8 (6.67)	41 (34.17)	34 (28.33)	37 (30.83)	0 (0.00)
Green leaf hopper (Grass hopper)	15 (12.50)	25 (20.83)	80 (66.67)	120 (100.00)	0 (0.00)	0 (0.00)	90 (75.00)	30 (25.00)	0 (0.00)	0 (0.00)	0 (0.00)
Major Diseases – Local variety											
Brown spot	12 (10.00)	81 (67.50)	27 (22.50)	120 (100.00)	0 (0.00)	0 (0.00)	9 (7.50)	64 (53.33)	47 (39.17)	0 (0.00)	0 (0.00)
Major Diseases – HYV variety											
Brown spot	13 (10.83)	70 (58.33)	37 (30.83)	120 (100.00)	0 (0.00)	0 (0.00)	5 (4.17)	91 (75.83)	24 (20.00)	0 (0.00)	0 (0.00)
Major Weeds – Local variety											
Echinochloa crusgalli	35 (29.17)	37 (30.83)	48 (40.00)	120 (100.00)	0 (0.00)	0 (0.00)	31 (25.83)	50 (41.67)	39 (32.50)	0 (0.00)	0 (0.00)
Ludwigia linifolia	13 (10.83)	55 (45.83)	52 (43.33)	120 (100.00)	0 (0.00)	0 (0.00)	44 (36.67)	37 (30.83)	39 (32.50)	0 (0.00)	0 (0.00)
Sacciolepis interrupta	9 (7.50)	39 (32.50)	72 (60.00)	120 (100.00)	0 (0.00)	0 (0.00)	34 (28.33)	19 (15.83)	67 (55.83)	0 (0.00)	0 (0.00)
Major Weeds – HYV variety											
Echnochloa crusgalli	33 (27.50)	50 (41.67)	37 (30.83)	120 (100.00)	0 (0.00)	0 (0.00)	11 (9.17)	55 (45.83)	54 (45.00)	0 (0.00)	0 (0.00)
Ludwigia linifolia	41 (34.17)	70 (58.33)	9 (7.50)	120 (100.00)	0 (0.00)	0 (0.00)	19 (15.83)	49 (40.83)	52 (43.33)	0 (0.00)	0 (0.00)
Sacciolepis interrupta	16 (13.33)	81 (67.50)	23 (19.17)	120 (100.00)	0 (0.00)	0 (0.00)	31 (25.83)	71 (59.17)	18 (15.00)	0 (0.00)	0 (0.00)
Monochoria vaginalis	33 (27.50)	59 (49.17)	28 (23.33)	120 (100.00)	0 (0.00)	0 (0.00)	25 (20.83)	61 (50.83)	34 (28.33)	0 (0.00)	0 (0.00)

Source: Primary Data
Note: Rank: * very important=1; important=2; not important=3
Frequency of attack: ** every season=1; once in two seasons=2; once in three seasons=3
Production loss : *** <5%=1; 5-10%=2; 10-25%=3; 25-50%=4; >50%=5
Parentheses figures indicate percentages.

In case of HYV paddy, the severity of stem borer was considered to be very important (rank1) by 56.67 per cent of the households, 33.33 per cent reported as important (rank 2) while 10.00 per cent reported as not so important(rank 3). The frequency of attack of stem borer was reported in every season by 100 per cent respondents. Production loss due to the attack of stem borer was less than 5 per cent as reported by 6.67 per cent, 5 to 10 per cent loss was reported by 35.00 per cent and 10 to 25 per cent loss was reported by 58.33 per cent of the respondents.

The severity of Gandhi bug was ranked as 1 (very important) by 49.17 per cent of the respondents , 37.50 per cent reported as important(rank 2) while 13.33 per cent reported as not so important(rank 3). The frequency of attack of Gandhi bug was reported in every season by 100 per cent respondents. Production loss due to the attack of Gandhi bug was less than 5 per cent as reported by 7.50 percent, 5 to 10 per cent loss was reported by 24.17 per cent and 10 to 25 per cent loss was reported by 32.50 per cent and 25 to 50 per cent loss was reported by 35.83 per cent of the respondents.

The severity of rice hispa was considered as very important (rank 1) by 51.67 per cent respondents, 45.00 per cent reported as important(rank 2) while 3.33 per cent reported as not so important (rank 3). The frequency of attack of rice hispa was reported in every season by 100 per cent respondents. Production loss due to the attack of rice hispa was less than 5 per cent as reported by 6.67 per cent, 5 to 10 per cent loss was reported by 34.17 per cent and 10 to 25 per cent loss was reported by 28.33 per cent and 25 to 50 per cent loss was reported by 30.83 per cent of the respondents.

The severity of green leaf hopper was considered very important (rank1) and was reported by 12.50 per cent of the respondents, 20.83 per cent reported as important (rank 2)while 66.67 per cent reported as not so important (rank 3). The frequency of attack of green leaf hopper was reported in every season by 100 per cent respondents. Production loss due to the attack of green leaf hopper was less than 5 per cent reported by 75.00 per cent of the respondents and5 to 10 per cent loss was reported by 25.00 per cent of the respondents.

The state witnessed 4 major diseases of paddy viz. Blast (early stage disease), Sheath blight, Brown spot (middle stage) and neck blast (Late stage). Among these, Brown spot was the major disease as reported by most of the respondents. In case of local paddy, the severity of Brown spot disease was ranked 1 (very important)

reported by 10.00 per cent of the respondents, 67.50 per cent reported as important (rank 2) while 22.50 per cent reported as not so important (rank 3). The frequency of attack of Brown spot was reported in every season by 100 per cent respondents. Production loss due to the attack of Brown spot was loss than 5 per cent reported by 7.50 per cent, 5 to 10 per cent loss was reported by 53.33 per cent and 10 to 25 per cent loss was reported by 39.17 per cent of the respondents. There was no report of production loss beyond this level.

In HYV paddy, the severity of Brown spot disease was considered to be very important(rank 1) reported by 10.83 per cent of the respondents, 58.33 per cent reported as important (rank 2)while 30.83 per cent reported as not so important (rank 3). The frequency of attack of Brown spot was reported in every season by 100 per cent respondents. Production loss due to the attack of Brown spot was less than 5 per cent reported by 4.17 per cent 5 to 10 per cent loss was reported by 75.83 per cent and 10 to 25 per cent loss was reported by 20.00 per cent of the respondents. There was no report of production loss beyond this level.

In the opinion of the farmers, paddy was also exposed to severe competition from weeds. Most of the weeds are found in the dormant stage at the time of plantation. They used to grow in faster rate in the initial stages of growth. Weeds can have two types attack on crops. Firstly, weeds are the hosts for many insects and secondly weeds absorb soil nutrients aggressively. As a result, it hampers the growth of the crops. Weed attack also varies on the topography of the land. Four major varieties of weeds which infest paddy crops severely are *Echinochloa Crusgalli*, *Ludwigia linifolia*, *Sacciolepis interrupta,* and *Monochoria vaginalis.*

In case of local paddy, the severity of the weed, *Echinochloa crusgalli,* was reported to be very important (rank 1) by 29.17 per cent of the respondents, 30.83 per cent reported as important (rank 2) while 40.00 per cent reported as not so important(rank 3). The frequency of attack of *Echinochloa crusgalli,* was reported in every season by 100 per cent of the respondents. Production loss due to the attack of *Echinochloa crusgalli,* was less 5 per cent reported by 25.83 per cent, 5 to 10 per cent less was reported by 41.67 per cent and 10 to 25 per cent loss was reported by 32.50 per cent of the respondents. There was no report of production loss beyond this level.

The severity of the weed, *Ludwigia linifolia,* was considered to be very important(rank 1) reported by 10.83 per cent the respondents, 45.83 per cent

reported as important(rank 2) while 43.33 per cent reported as not so important (rank 3). The frequency of attack of *Ludwigia linifolia*, was reported in every season by 100 per cent respondents. Production loss due to the attack of *Ludwigia linifolia* was less than 5 per cent reported by 36,67 per cent of the respondents, 5 to 10 per cent loss was reported by 30.83 per cent and 10 to 25 per cent loss was reported by 32.50 per cent of the respondents. There was no report of production loss beyond this level.

The severity of the weed, *Sacciolepis interrupta*, was considered very important (rank 1) reported by 7.50 per cent of the respondents, 32.50 per cent reported as important(rank 2) while 60.00 per cent reported as not so important (rank 3). The frequency of attack of *Sacciolepis interrupta*, was reported in every season by 100 per cent respondents. Production loss due to the attack of Sacciolepis *interrupta*, was less than 5 per cent reported by 28.33 per cent, 5 to 10 per cent less was reported by 15.83 per cent and 10 to 25 per cent loss was reported by 55.83 per cent of the respondents. There was no report of production loss beyond this level.

In case of HYV paddy, the rank of severity of the weed, *Echinochloa crusgalli*, was reported to be very important (rank 1) by 27.50 per cent of the respondents, 41.67 per cent reported as important(rank 2) while 30.83 per cent reported as not so important (rank 3). The frequency of attack of *Echinochloa crusgalli*, was reported in every season by 100 per cent respondents. Production loss due to the attack of Echinochloa crusgalli, was less than 5 per cent reported by 9.17 per cent of the respondents, 5 to 10 per cent loss was reported by 45.83 per cent and 10 to 25 per cent loss was reported by 45.00 per cent of the respondents.

The rank of severity of the weed, *Ludwigia linifolia,* was reported to be very important (rank1) by 34.17 per cent of the respondents, 58.33 per cent reported as important(rank 2) while 7.50 per cent reported as not so important (rank 3). The frequency of attack of *Ludwigia linifolia*, was reported in every season by 100 per cent of the respondents. Production loss due to the attack of *Ludwigia linifolia*, was less than 5 per cent reported by 15.83 per cent of the respondents, 5 to 10 per cent loss was reported by 40.83 per cent and 10 to 25 per cent loss was reported by 43.33 per cent of the respondents. There was no report of production loss beyond this level.

The rank of severity of the weed, *Sacciolepis interrupta*, was reported to be very important (rank 1) by 13.33 per cent of the respondents, 67.50 per cent reported as important (rank 2) while 19.17 per cent reported as not so important(rank 3). The frequency of attack of *Sacciolepis interrupta*, was reported in every season

by 100 per cent respondents. Production loss due to the attack of *Sacciolepis interrupta*, was less 5 than per cent was reported by 25.83 per cent, 5 to 10 per cent less was reported by 59.17 per cent , 10 to 25 per cent loss was reported by 15.00 per cent of the respondents. There was no report of production loss beyond this level.

The rank of severity of the weed, *Monochoria vaginalis*, was considered to be very important (rank 1) reported by 27.50 per cent of the respondents, 49.17 per cent reported as important (rank 2) while 23.33 per cent reported as not so important (rank 3). The frequency of attack of Sacciolepis interrupta, was reported in every season by 100 per cent respondents. Production loss due to the attack of *Sacciolepis interrupta*, was less than 5 per cent reported by 20.83 per cent, 5 to 10 per cent loss was reported by 50.83 per cent and 10 to 25 per cent loss was reported by 28.33 per cent of the respondents. There was no report of production loss beyond this level.

Table-4.2c gives the incidence of major pests and diseases of Crop-II (Wheat). All the farmers cultivated HYV wheat only. As per report of the farmers, generally there were three major pests which infested the wheat crop severely but the severity of attack for all the growers were not same. Aphids (early stage), stem borer (middle stage) and rat were the major pests of wheat. During the field survey, respondents reported that the stem borer was the major pest in the locality. The severity of attack due to stem borer was reported to be very important (rank 1) by 24.17 per cent of the respondents, 46.67 per cent reported as important (rank 2) while 29.17 per cent reported as not so important(rank 3). The attack of stem borer was witnessed in every season by 100 per cent respondents. Production loss due to the attack of stem borer was less than 5 per cent reported by 5.83 per cent respondents, 5 to 10 per cent loss was reported by 42.50 per cent and 10 to 25 per cent loss was reported by 51.67 per cent of the respondents. There was no report of production loss beyond this level.

Loose smart and Leaf blight were the two major diseases of wheat crop. The rank severity due to the attack of *Loose smart* was reported to be very important (rank 1) by 26.67 per cent respondents, 52.50 per cent reported as important (rank 2) while 22.50 per cent reported as not so important (rank 3). The attack of *loose smart* was reported in every season by 100 per cent respondents. Production loss due to the attack of *Lose smart* was less than 5 per cent was reported by 22.50 per cent, 5 to 10 per cent loss was reported by 29.17per cent and 10 to 25 per cent loss was reported by 48.33 per cent of the respondents.

In case of *Leaf blight*, the severity was reported to be very important(rank 1) by 22.50 per cent respondents, 68.33 per cent reported as important (rank 2) while 9.17 per cent reported as not so important (rank 3). The attack of *Leaf blight* was reported in every season by 100 per cent respondents. Production loss due to the attack of *Leaf blight* was less than 5 per cent reported by 10.00 per cent, 5 to10 per cent loss was reported by 28.33 per cent and 10 to 25 per cent loss was reported by 61.67 per cent of the respondents. There was no report of production loss beyond this level.

Table-4.2c
Incidence of major pests and disease - Crop II (Wheat)

Name of the pest/disease/weed	Rank of severity*			Frequency of attack**			Production loss***				
	1	2	3	1	2	3	1	2	3	4	5
Major Pests – Local variety											
Not reported	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Major Pests - HYV variety											
Stem borer	29 (24.17)	56 (46.67)	35 (29.17)	120 (100.00)	0 (0.00)	0 (0.00)	7 (5.83)	51 (42.50)	62 (51.67)	0 (0.00)	0 (0.00)
Major Diseases – Local variety											
Not reported	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Major Diseases – HYV variety											
Lose smart	32 (26.67)	63 (52.50)	27 (22.50)	120 (100.00)	0 (0.00)	0 (0.00)	27 (22.50)	35 (29.17)	58 (48.33)	0 (0.00)	0 (0.00)
Leaf blight	27 (22.50)	82 (68.33)	11 (9.17)	120 (100.00)	0 (0.00)	0 (0.00)	12 (10.00)	34 (28.33)	74 (61.67)	0 (0.00)	0 (0.00)
Major Weeds – Local variety											
Not reported	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Major Weeds – HYV variety											
Cynodon dactylon	15 (12.50)	53 (44.17)	52 (43.33)	120 (100.00)	0 (0.00)	0 (0.00)	25 (20.83)	33 (27.50)	62 (51.67)	0 (0.00)	0 (0.00)
Chenopodium album	27 (22.50)	49 (40.83)	44 (36.67)	120 (100.00)	0 (0.00)	0 (0.00)	39 (32.50)	37 (30.83)	44 (36.67)	0 (0.00)	0 (0.00)
Polygonum viscosum	19 (15.83)	71 (59.17)	30 (25.00)	120 (100.00)	0 (0.00)	0 (0.00)	14 (11.67)	64 (53.33)	42 (35.00)	0 (0.00)	0 (0.00)

Source: Primary Data
Note: * very important=1; important=2; not important=3
** every season=1; once in two seasons=2; once in three seasons=3
*** <5%=1; 5-10%=2; 10-25%=3; 25-50%=4; >50%=5
Parentheses figures indicate percentages.

The three major weeds which infested wheat crops were *Cynodon dactylon*, *Chenopodium album* and *Polygonum viscosum*. In case of *Cynodon dactylon* the severity was reported to be very important (rank 1) by 12.50 per cent respondents, 44.17 per cent reported as important (rank 2) while 43.33 per cent reported as not so important (rank 3). The attack of *Cynodon dactylon* was reported in every season by 100 per cent respondents. Production loss due to attack of *Cynodon dactylon*, was less than 5 per cent reported by 20.83 per cent respondents, 5 to 10 per cent loss

reported by 27.50 per cent and 10 to 25 per cent loss reported by 51.67 per cent of the respondents. There was no report of production loss beyond this level.

In case of *Chenopodium album*, the severity was considered to be very important (rank 1) reported by 22.50 per cent of the respondents, 40.83 per cent reported as important (rank 2) while 36.67 per cent reported as not so important (rank 3). The attack of *Chenopodium album* was reported in every season by 100 per cent of the respondents. Production loss due to the attack of *Chenopodium album*, was less than 5 per cent reported by 32.50 per cent, 5 to 10 per cent loss was reported by 30.83 per cent and 10 to 25 per cent loss was reported by 36.67 per cent of the respondents. There was no report of production loss beyond this level.

In case of *Polygonal viscosum*, the severity was reported to be very important (rank 1) by 15.83 per cent of the respondents, 59.17 per cent reported as important (rank 2) while 25.00 per cent reported as not so important (rank 3). The attack of *Polygonum viscosum* was reported in every season by 100 per cent of the respondents. Production loss due to attack of *Polygonum viscosum*, was less than 5 per cent reported by 11.67 per cent, 5 to 10 per cent less reported by 53.33 per cent and 10 to 25 per cent loss was reported by 35.00 per cent of the respondents. There was no report of production loss beyond this level.

Table-4.2d visualizes the percentage losses over the actual production due to the attack of pests, diseases and weed infestations and normal production without attack in paddy (Local and HYV) across the different farm size groups. Crop losses in HYV paddy was found at a higher side as compared to local paddy. It indicates that the resistance of local paddy against infestation is more than that of HYV paddy but the productivity of local paddy could not compete with HYV paddy. The loss over the actual production of local paddy, ranged between 5.37 and 8.25 per cent while in HYV paddy, it stood between 6.18 and 9.53 per cent across the different farm size groups. The overall losses occurred at 7.14 and 8.44 per cent for local and HYV paddy, respectively. The loss over normal production of local paddy, lied between 5.23 and 7.62 per cent while in HYV paddy, it lied between 5.82 and 8.70 per cent across the farm size groups. The overall losses stood at 6.66 and 7.79 per cent for local and HYV paddy, respectively.

Table-4.2d
The magnitude of crop loss due to pests, disease and weed infestation - Crop I (Paddy)

Description	Marginal		Small		Medium		Large		Total	
	Local	HYV	Local	HYV	Local	HYV	Local	HYV	Local	HYV
Actual production with attack (quintal/ha)	30.25	42.73	28.96	35.89	26.77	33.19	26.89	30.82	27.99	35.35
Normal production without attack (quintal/ha)	32.09	45.55	30.51	38.80	28.25	35.24	29.11	33.76	29.99	38.34
Loss of output (quintal/ha)	1.84	2.82	1.55	2.91	1.48	2.05	2.22	2.94	2.00	2.98
Percentage loss over actual production	6.09	6.59	5.37	8.12	5.51	6.18	8.25	9.53	7.14	8.44
Percentage loss over normal production	5.74	6.18	5.09	7.51	5.23	5.82	7.62	8.70	6.66	7.79

Source: Primary Data

Similarly, Table-4.2e shows the amount of crop loss due to pests, diseases and weed infestations in wheat crop. There was no report of cultivation of wheat with local seeds. It was observed that the amount of crop loss in wheat was significantly higher than that of paddy.

Table -4.2e
The magnitude of crop loss due to pests, disease and weed infestation- Crop II (wheat)

Description	Marginal		Small		Medium		Large		Total	
	Local	HYV	Local	HYV	Local	HYV	Local	HYV	Local	HYV
Actual production with attack (quintal/ha)	0.00	20.49	0.00	18.35	0.00	18.25	0.00	14.94	0.00	18.53
Normal production without attack (quintal/ha)	0.00	24.34	0.00	21.31	0.00	22.07	0.00	18.21	0.00	21.48
Loss of output (quintal/ha)	0.00	3.85	0.00	2.96	0.00	3.82	0.00	3.27	0.00	2.96
Percentage loss over actual production	0.00	18.80	0.00	16.11	0.00	20.91	0.00	21.89	0.00	15.96
Percentage loss over normal production	0.00	15.82	0.00	13.87	0.00	17.30	0.00	17.96	0.00	13.76

Source: Primary Data

In this regard, farmers opined that the seed variety and climatic conditions of the state do not support each other for which the crop is badly exposed to diseases. The farmers reported that the pre monsoon shower at the time of harvesting gives vent to more disease infestation. The loss over actual production was found in between 16.11 and 21.89 per cent across the farm sizes with an overall loss of 15.96 per cent. The loss over the normal production was found in between 13.87 and 17.96 per cent across the farm sizes with an overall loss of 13.76 per cent.

4.3 Methods of pest and diseases control adopted by the selected sample households

Generally, there are two methods for control of pests and diseases in the crop field as adopted by the respondent farmers- traditional and biological method. Use of

chemical pesticides was considered to be a traditional method while biological method takes maximum care against degradation of environment. A large section of the farmers were aware of the danger of indiscriminate use of chemicals. At the same time, the farmers had reports of increasing resistance of pest to some chemicals. In this regard, Integrated Pest Management (IPM) was considered as a useful strategy to combat with the menaces. But the programme is yet to make a breakthrough in the crop field. Table-4.3a, 4.3b and 4.3c give the percentage of sample households adopting different methods along with the cost incurred in weedicide, insecticide, fungicide and labour charge per hectare for crop-I and crop-II across the farm size groups. On an average, 89.17 and 76.67 per cent of the households were found to use

Table-4.3a
Cost of Chemical methods adopted for Pests and disease control–Crop-I(Paddy)

(Rs/ha)

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	86.21	92.98	84.38	100.00	89.17
Weedicide					
No. of sprays/ha	0	0	0	0	0
Cost of chemicals*	0.00	0.00	0.00	0.00	0.00
Labour charges	632.04	681.61	742.53	956.93	753.28
Total Cost	632.04	681.61	742.53	956.93	753.28
Insecticide					
No. of sprays/ha	1.00	1.00	1.00	1.00	1.00
Cost of chemicals	80.68	100.85	141.18	181.52	126.06
Labour charges	450.00	542.50	487.50	637.50	529.38
Total Cost	530.68	643.35	628.68	819.02	655.43
Fungicide					
No. of sprays/ha	1.00	1.00	1.00	1.00	1.00
Cost of chemicals	64.06	91.51	109.81	146.41	102.95
Labour charges	480.00	490.00	503.75	600.00	518.44
Total Cost	544.06	581.51	613.56	746.41	621.38

Source: Primary data
Note: * The control of weeds by hand without using chemicals.

chemicals for control of pests and diseases in crop-I and Crop-II, respectively. There was no report of using weedicide in the study area but uprooting of weeds was done manually (by hand without using chemicals) for both the crops. On an average, per hectare cost for weed control was Rs.753.28 for crop-I and Rs. 986.99 for crop-II. It was reported by the Crop –II growers that they had to go for weeding at least for two times in a season. To control the pests attack, one time chemical spray was reported to be sufficient enough for each crop. Cost of chemical per hectare also varied with the type of chemicals used and their price.

Table-4.3b
Cost of Chemical methods adopted for pests and disease control - Crop II (Wheat)

(Rs/ha.)

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	55.00	80.00	82.14	100.00	76.67
Weedicide					
No. of sprays/ha	0	0	0	0	0
Cost of chemicals*	0.00	0.00	0.00	0.00	0.00
Labour charges	660.80	953.00	1489.95	844.20	986.99
Total Cost	660.80	953.00	1489.95	844.20	986.99
Insecticide					
No. of sprays/ha	1.00	1.00	1.00	1.00	1.00
Cost of chemicals	176.75	252.50	315.63	441.88	296.69
Labour charges	311.75	387.50	400.00	450.00	387.31
Total Cost	488.50	640.00	715.63	891.88	684.00
Fungicide					
No. of sprays/ha	1.00	1.00	1.00	1.00	1.00
Cost of chemicals	111.25	155.75	233.63	278.13	194.69
Labour charges	217.50	310.00	360.00	375.00	315.63
Total Cost	328.75	465.75	593.63	653.13	510.31

Source: Primary data
Note: * The control of weeds by hand without using chemicals.

The overall cost of spraying of insecticides including labour charge was worked at Rs. 655.43 for crop –I and Rs. 684.00 for crop-II /ha.. In case of fungicides, the overall cost incurred was Rs. 621.38 per hectare for crop-I and Rs. 510.31 for crop-II per hectare.

Only 13 households (10.83%) adopted biological method using leaves of Neem tree for pests and diseases control in crop-I (table-4.3c)

Table-4.3c
Details of biological methods adopted for pests and disease control

Item		Crop – I(Paddy)		Crop – II(wheat)	
		Percentage of HH adopted the method	Details about the method	Percentage of HH adopted the method	Details about the method
Biological methods		10.83	Leaves of Neem tree	0.00	0.00
Other Control measures	1	0.00	0.00	0.00	0.00
	2	0.00	0.00	0.00	0.00

4.4 Sources of information for pests and diseases control by the selected Households

It was reported that incidence of pest and disease was very much common in the study area for all the field crops. The farmers used to seek technical advice from different sources only when severity of attack went beyond a certain level. Table-4.4 summarizes the farmers' opinion of on different sources of information. Nearly 74.17 per cent of the households sought for technical advice in case of Crop-I and 60.83 per cent for in case of crop-II pests and disease control. **For the growers of crop** (normal fact) **–I,** fellow farmers (39.33%) were the most important source and for crop-II,

Government extension agent (45.21%) was the most important source of information. The information & services received by the sample farmers from different agencies were found to be very useful for control of pests and diseases in the field.

Table - 4.4

Extension services on pests and disease control management (percentage of HHs)

	Crop - I (Paddy)				**Crop - II (Wheat)**			
Percentage of HH seeking advice	**74.17**				**60.83**			
Rank of sources ⇨ Sources of advice ⇩	Most imp	Important	Least imp	Details of advice	Most imp	Important	Least imp	Details of advice
Government extension agent	19.10	39.33	7.87	Very useful	45.21	20.55	30.14	Very useful
Private input dealer	0.00	0.00	10.11	Useful	0.00	0.00	0.00	Useful
Fellow farmers	39.33	13.48	23.60	Very useful	30.14	72.60	16.44	Very useful
TV/Radio service/Newspaper	3.37	5.62	39.33	Useful	0.00	0.00	0.00	Useful
Agricultural University/KVK	13.48	33.71	19.10	Very useful	15.07	12.33	50.68	Very useful
Any other	0.00	0.00	0.00		0.00	0.00	0.00	

Source: Primary data

4.5 Household suggestions on how to minimize pre harvest losses

Following suggestions are incorporated here on the basis of the interaction with the sample farmers:

- Delay in diagnosis of the attack of pests and diseases often increases pre harvest losses. Most of the times, the farmers are to look for external agencies for mitigation/ control of pest & diseases. Long waiting time results in more pre-harvest losses, therefore timely diagnosis of the problem & quick action thereon deemed necessary.
- Recommended insecticides or pesticides are not always available in the market to take immediate action. Field visit by the officials of the line department at regular interval should be closely monitored & they should arranged for ensuring the availability of required insecticides or pesticides well in advance.
- High input cost stands as an impediment for adoption of full package of technology for pest & diseases management. The Govt. may either go containing the price, or may provide for relief to the poor farmers.
- Farmers are also aware of the probable side effect of agro chemicals which very often deter them to go for its application in the field. They are always interested to adopt other means to mitigate the incidence of pests and diseases. Under the situation, this pesticide may be popularized.

- The prices of the produces are not remunerative. Therefore, the farmers cannot spend much to prevent crop losses due to pests and diseases. Prices may therefore, be fixed on the basis cost of production along with a reasonable margin.
- It was reported that most of the pests and diseases in crops come from the soil first. As such, soil testing before planting/sowing is always recommended so that all the precautionary measures can be taken up well on time.
- Only a section of farmers are aware of IPM/IDM module. But they need adequate training by the competent professionals. The Department may come forward to train them up accordingly.
- The Department may launch massive capacity building programme to train the farmers on latest technology which can reduce the crop losses due to pests and diseases.
- It is said, **"Delay is the enemy of efficiency and waiting is the enemy of utilization."** As such, whenever there is report of pest and diseases infestation, one should immediately resort to protective measure without any time lag.
- However, crop losses for any abiotic factors like severe draught and floods are beyond human endeavor.

4.6 Summary of the chapter

This chapter has designed to assess of pre harvest losses of paddy and wheat and also to ascertain the kind of constraints faced by the farmers.

Severity of the constraints was measured in terms of the percentages of households to the total sample households. Here crop-I and crop-II indicates paddy and wheat, respectively. In case of crop-I, 92.50 per cent of the total sample households (120), opined that low output price was the most important constraint for them while in case of crop-II, 65.00 per cent of the total sample households considered it to be the most important constraints. In case of pests and diseases, 23.33 per cent for crop-I and 90.83 for Crop-II per cent of the households opined as the most important constraint for them. For crop-I, 69.17 per cent of households opined that the high cost of inputs was the most important constraint for them and it was 87.50 per cent for crop-II. The most important constraint as reported by 52.50 per cent households in case of crop-I was water deficiency and 67.50 per cent considered it to be the most important for Crop-II. The poor seed quality was the most important

constraints as identified by the 27.50 and 58.33 per cent of households for crop-I and crop-II, respectively.

Crop damage by pests and diseases in the farmer's field was usually detected by the farmers on visual observation. Most of the farmers rarely could identify the symptoms of pests and diseases in the early stage of attack. They mostly depended upon the village extension workers or other technical officers from the District Agricultural Office. However, in the later stage of pest and disease infestations, a large percentage of the farmers acquired adequate knowledge on the symptoms of pest and diseases. But they had never done any quantitative assessment of the attack. Table-4.2a gives the views of the farmers in identification of pests and diseases attack in terms percentage of households. For crop-I, 60 per cent of the households could distinguish pest and disease attack from their past experience of knowledge and it was 53.33 per cent for Crop-II. The same percentages of households had reported to have done qualitative assessment about the severity of the attack for both the crops.

The incidence of major pests, diseases and weeds of local and HYV paddy, frequency of attack and production losses on the basis of the observation made by the respondents in terms percentage to the total respondents (120). The farmers also had different opinions on severity of incidence of attacks which were influenced by the type of seeds used, fertilizer and FYM used, topography of the land, soil fertility, water level of the field, intensity of rainfall, sun shine hours, etc. They cited an example that the weed infestation is very high in high land as compared to medium and low land. Similarly, growth of the crops is generally high when fertilizer is applied and crop plants become creating a favorable environment for pests and diseases. That was why; there was a variation of opinions among the respondent. Rank of severity of attack was measured by three different opinions as expressed by the farmers- rank 1 stood for very important, rank 2 stood for important and rank 3 stood for not important. There were 4 major pests for paddy *viz.* paddy stem borer, *gandhi* bug, Rice hispa and Green leaf hopper. Production losses due to attack of pests and diseases was measured in terms percentage (given in the table below) as reported by the respondents.

In local paddy, the rank of severity of stem borer was 1, i.e., very important as reported by 51.67 per cent households, 40.00 per cent reported as important (2) while 8.33 per cent found it to be not important (3). The frequency of attack of stem borer was reported in every season by 100 per cent respondents. The intensity of

production losses due to attack of insects were measured in terms the percentage of sample households in 5 categories numbered from 1 to 5, where loss 1 stands for less than 5 per cent, loss 2 between 5 to 10 per cent , loss 3 between 10 to 25 per cent, loss 4 between 25 to 50 per cent and loss 5 lies above 50 per cent. The intensity of production losses due to attack of stem borer was found to be less than 5 per cent and was reported by 20.00 per cent households, 5 to 10 per cent loss was reported by 32.50 per cent of households and 10 to 25 per cent loss was reported by 47.50 per cent respondents.

The rank of severity of *gandhi* bug was 1(very important) reported by 49.17 per cent respondents, 29.17 per cent reported as important while 21.67 per cent reported as not important. The frequency of attack of Gandhi bug was reported in every season by 100 per cent respondents and there was no report of attack under two other situations. Production loss due to the attack of Gandhi bug was less than 5 per cent as reported by 17.50 percent households, 5 to 10 per cent loss was reported by 40.83 per cent households, 10 to 25 per cent loss was reported by 38.33 per cent households and 25 to 50 per cent loss was reported by 3.33 per cent respondents.

The severity of rice hispa was ranked as very important by 37.50 per cent respondents, 50.83 per cent reported it to be important while 11.67 per cent reported as not important. The frequency of attack of rice hispa was reported in every season by 100 per cent respondents. Production loss due to the attack of rice hispa was less than 5 per cent as reported by 15.00 per cent households, 5 to 10 per cent loss was reported by 29.17 per cent households, 10 to 25 per cent loss was reported by 49.17 per cent households and 25 to 50 per cent loss was reported by 6.67 per cent respondents.

The rank of severity against green leaf hopper was considered very important and was reported by 26.67 per cent of the respondent, 19.17 per cent reported as important while 54.17 per cent reported as not so important. The frequency of attack of green leaf hopper was reported in every season by 100 per cent respondents. Production loss due to the attack of green leaf hopper was less than 5 per cent and was reported by 13.33 per cent, 5 to 10 per cent loss was reported by 66.67 per cent and 10 to 25 per cent loss was reported by 20.00 per cent respondents.

In case of HYV paddy, the severity of stem borer was considered very important by 56.67 per cent of the households, 33.33 per cent reported as important while 10.00 per cent reported as not so important. The frequency of attack of stem

borer was reported in every season by 100 per cent respondents. Production loss due to the attack of stem borer was less than 5 per cent as reported by 6.67 per cent, 5 to 10 per cent loss was reported by 35.00 per cent and 10 to 25 per cent loss was reported by 58.33 per cent of the respondents.

The severity of Gandhi bug was ranked as 1 (very important) by 49.17 per cent of the respondents , 37.50 per cent reported as important(rank 2) while 13.33 per cent reported as not so important(rank 3). The frequency of attack of Gandhi bug was reported in every season by 100 per cent respondents. Production loss due to the attack of Gandhi bug was less than 5 per cent as reported by 7.50 percent, 5 to 10 per cent loss was reported by 24.17 per cent and 10 to 25 per cent loss was reported by 32.50 per cent and 25 to 50 per cent loss was reported by 35.83 per cent of the respondents.

The severity of rice hispa was considered as very important (rank 1) by 51.67 per cent respondents, 45.00 per cent reported as important(rank 2) while 3.33 per cent reported as not so important (rank 3). The frequency of attack of rice hispa was reported in every season by 100 per cent respondents. Production loss due to the attack of rice hispa was less than 5 per cent as reported by 6.67 per cent, 5 to 10 per cent loss was reported by 34.17 per cent and 10 to 25 per cent loss was reported by 28.33 per cent and 25 to 50 per cent loss was reported by 30.83 per cent of the respondents.

The severity of green leaf hopper was considered very important (rank1) and was reported by 12.50 per cent of the respondents, 20.83 per cent reported as important (rank 2)while 66.67 per cent reported as not so important (rank 3). The frequency of attack of green leaf hopper was reported in every season by 100 per cent respondents. Production loss due to the attack of green leaf hopper was less than 5 per cent reported by 75.00 per cent of the respondents and5 to 10 per cent loss was reported by 25.00 per cent of the respondents.

The state witnessed 4 major diseases of paddy viz., Blast (early stage disease), Sheath blight, Brown spot (middle stage) and neck blast (Late stage). Among these, Brown spot was the major disease as reported by most of the respondents. In case of local paddy, the severity of Brown spot disease was ranked 1 (very important) reported by 10.00 per cent of the respondents, 67.50 per cent reported as important (rank 2) while 22.50 per cent reported as not so important (rank 3). The frequency of attack of Brown spot was reported in every season by 100 per cent respondents.

Production loss due to the attack of Brown spot was loss than 5 per cent reported by 7.50 per cent, 5 to 10 per cent loss was reported by 53.33 per cent and 10 to 25 per cent loss was reported by 39.17 per cent of the respondents. There was no report of production loss beyond this level.

In HYV paddy, the severity of Brown spot disease was considered to be very important(rank 1) reported by 10.83 per cent of the respondents, 58.33 per cent reported as important (rank 2)while 30.83 per cent reported as not so important (rank 3). The frequency of attack of Brown spot was reported in every season by 100 per cent respondents. Production loss due to the attack of Brown spot was less than 5 per cent reported by 4.17 per cent 5 to 10 per cent loss was reported by 75.83 per cent and 10 to 25 per cent loss was reported by 20.00 per cent of the respondents. There was no report of production loss beyond this level.

In the opinion of the farmers, paddy was also exposed to severe competition from weeds. Most of the weeds are found in the dormant stage at the time of plantation. They used to grow in faster rate in the initial stages of growth. Weeds can have two types attack on crops. Firstly, weeds are the hosts for many insects and secondly weeds absorb soil nutrients aggressively. As a result, it hampers the growth of the crops. Weed attack also varies on the topography of the land. Four major varieties of weeds which infest paddy crops severely are *Echinochloa Crusgalli*, *Ludwigia linifolia*, *Sacciolepis interrupta,* and *Monochoria vaginalis.*

In case of local paddy, the severity of the weed, *Echinochloa crusgalli*, was reported to be very important (rank 1) by 29.17 per cent of the respondents, 30.83 per cent reported as important (rank 2) while 40.00 per cent reported as not so important(rank 3). The frequency of attack of *Echinochloa crusgalli*, was reported in every season by 100 per cent of the respondents. Production loss due to the attack of *Echinochloa crusgalli*, was less 5 per cent reported by 25.83 per cent, 5 to 10 per cent less was reported by 41.67 per cent and 10 to 25 per cent loss was reported by 32.50 per cent of the respondents. There was no report of production loss beyond this level.

The severity of the weed, *Ludwigia linifolia,* was considered to be very important(rank 1) reported by 10.83 per cent the respondents, 45.83 per cent reported as important(rank 2) while 43.33 per cent reported as not so important (rank 3). The frequency of attack of *Ludwigia linifolia*, was reported in every season by 100 per cent respondents. Production loss due to the attack of *Ludwigia linifolia* was

less than 5 per cent reported by 36,67 per cent of the respondents, 5 to 10 per cent loss was reported by 30.83 per cent and 10 to 25 per cent loss was reported by 32.50 per cent of the respondents. There was no report of production loss beyond this level.

The severity of the weed, *Sacciolepis interrupta*, was considered very important (rank 1) reported by 7.50 per cent of the respondents, 32.50 per cent reported as important(rank 2) while 60.00 per cent reported as not so important (rank 3). The frequency of attack of *Sacciolepis interrupta*, was reported in every season by 100 per cent respondents. Production loss due to the attack of *Sacciolepis interrupta*, was less than 5 per cent reported by 28.33 per cent, 5 to 10 per cent less was reported by 15.83 per cent and 10 to 25 per cent loss was reported by 55.83 per cent of the respondents. There was no report of production loss beyond this level.

In case of HYV paddy, the rank of severity of the weed, *Echinochloa crusgalli*, was reported to be very important (rank 1) by 27.50 per cent of the respondents, 41.67 per cent reported as important(rank 2) while 30.83 per cent reported as not so important (rank 3). The frequency of attack of *Echinochloa crusgalli*, was reported in every season by 100 per cent respondents. Production loss due to the attack of Echinochloa crusgalli, was less than 5 per cent reported by 9.17 per cent of the respondents, 5 to 10 per cent loss was reported by 45.83 per cent and 10 to 25 per cent loss was reported by 45.00 per cent of the respondents.

The rank of severity of the weed, *Ludwigia linifolia,* was reported to be very important (rank1) by 34.17 per cent of the respondents, 58.33 per cent reported as important(rank 2) while 7.50 per cent reported as not so important (rank 3). The frequency of attack of *Ludwigia linifolia*, was reported in every season by 100 per cent of the respondents. Production loss due to the attack of *Ludwigia linifolia*, was less than 5 per cent reported by 15.83 per cent of the respondents, 5 to 10 per cent loss was reported by 40.83 per cent and 10 to 25 per cent loss was reported by 43.33 per cent of the respondents. There was no report of production loss beyond this level.

The rank of severity of the weed, *Sacciolepis interrupta*, was reported to be very important (rank 1) by 13.33 per cent of the respondents, 67.50 per cent reported as important (rank 2) while 19.17 per cent reported as not so important(rank 3). The frequency of attack of *Sacciolepis interrupta*, was reported in every season by 100 per cent respondents. Production loss due to the attack of *Sacciolepis interrupta*, was less 5 than per cent was reported by 25.83 per cent, 5 to 10 per cent

less was reported by 59.17 per cent, 10 to 25 per cent loss was reported by 15.00 per cent of the respondents. There was no report of production loss beyond this level.

The rank of severity of the weed, *Monochoria vaginalis*, was considered to be very important (rank 1) reported by 27.50 per cent of the respondents, 49.17 per cent reported as important (rank 2) while 23.33 per cent reported as not so important (rank 3). The frequency of attack of Sacciolepis interrupta, was reported in every season by 100 per cent respondents. Production loss due to the attack of *Sacciolepis interrupta*, was less than 5 per cent reported by 20.83 per cent, 5 to 10 per cent loss was reported by 50.83 per cent and 10 to 25 per cent loss was reported by 28.33 per cent of the respondents. There was no report of production loss beyond this level.

All the farmers cultivated HYV wheat only. As per report of the farmers, generally there were three major pests which infested the wheat crop severely but the severity of attack for all the growers were not same. Aphids (early stage), stem borer (middle stage) and rat were the major pests of wheat. During the field survey, respondents reported that the stem borer was the major pest in the locality. The severity of attack due to stem borer was reported to be very important (rank 1) by 24.17 per cent of the respondents, 46.67 per cent reported as important (rank 2) while 29.17 per cent reported as not so important(rank 3). The attack of stem borer was witnessed in every season by 100 per cent respondents. Production loss due to the attack of stem borer was less than 5 per cent reported by 5.83 per cent respondents, 5 to 10 per cent loss was reported by 42.50 per cent and 10 to 25 per cent loss was reported by 51.67 per cent of the respondents. There was no report of production loss beyond this level.

Loose smart and Leaf blight were the two major diseases of wheat crop. The rank severity due to the attack of *Loose smart* was reported to be very important (rank 1) by 26.67 per cent respondents, 52.50 per cent reported as important (rank 2) while 22.50 per cent reported as not so important (rank 3). The attack of *Loose smart* was reported in every season by 100 per cent respondents. Production loss due to the attack of *Lose smart* was less than 5 per cent was reported by 22.50 per cent, 5 to 10 per cent loss was reported by 29.17per cent and 10 to 25 per cent loss was reported by 48.33 per cent of the respondents.

In case of *Leaf blight*, the severity was reported to be very important(rank 1) by 22.50 per cent respondents, 68.33 per cent reported as important (rank 2) while 9.17 per cent reported as not so important (rank 3). The attack of *Leaf blight* was

reported in every season by 100 per cent respondents. Production loss due to the attack of *Leaf blight* was less than 5 per cent reported by 10.00 per cent, 5 to 10 per cent loss was reported by 28.33 per cent and 10 to 25 per cent loss was reported by 61.67 per cent of the respondents. There was no report of production loss beyond this level.

The three major weeds which infested wheat crops were *Cynodon dactylon, Chenopodium album* and *Polygonum viscosum*. In case of *Cynodon dactylon* the severity was reported to be very important (rank 1) by 12.50 per cent respondents, 44.17 per cent reported as important (rank 2) while 43.33 per cent reported as not so important (rank 3). The attack of *Cynodon dactylon* was reported in every season by 100 per cent respondents. Production loss due to attack of *Cynodon dactylon*, was less than 5 per cent reported by 20.83 per cent respondents , 5 to 10 per cent loss reported by 27.50 per cent and 10 to 25 per cent loss reported by 51.67 per cent of the respondents. There was no report of production loss beyond this level.

In case of *Chenopodium album*, the severity was considered to be very important (rank 1) reported by 22.50 per cent of the respondents, 40.83 per cent reported as important (rank 2) while 36.67 per cent reported as not so important (rank 3). The attack of *Chenopodium album* was reported in every season by 100 per cent of the respondents. Production loss due to the attack of *Chenopodium album*, was less than 5 per cent reported by 32.50 per cent, 5 to 10 per cent leos was reported by 30.83 per cent and 10 to 25 per cent loss was reported by 36.67 per cent of the respondents. There was no report of production loss beyond this level.

In case of *Polygonal viscosum*, the severity was reported to be very important (rank 1) by 15.83 per cent of the respondents, 59.17 per cent reported as important (rank 2) while 25.00 per cent reported as not so important (rank 3). The attack of *Polygonum viscosum* was reported in every season by 100 per cent of the respondents. Production loss due to attack of *Polygonum viscosum*, was less than 5 per cent reported by 11.67 per cent, 5 to 10 per cent less reported by 53.33 per cent and 10 to 25 per cent loss was reported by 35.00 per cent of the respondents. There was no report of production loss beyond this level.

The percentage losses over the actual production due to the attack of pests, diseases and weed infestations and normal production without attack in paddy (Local and HYV) across the different farm size groups have been observed. Crop losses in HYV paddy was found at a higher side as compared to local paddy. It indicates that

the resistance of local paddy against infestation is more than that of HYV paddy but the productivity of local paddy could not compete with HYV paddy. The loss over the actual production of local paddy, ranged between 5.37 and 8.25 per cent while in HYV paddy, it stood between 6.18 and 9.53 per cent across the different farm size groups. The overall losses occurred at 7.14 and 8.44 per cent for local and HYV paddy, respectively. The loss over normal production of local paddy, lied between 5.23 and 7.62 per cent while in HYV paddy, it lied between 5.82 and 8.70 per cent across the farm size groups. The overall losses stood at 6.66 and 7.79 per cent for local and HYV paddy, respectively.

There was no report of cultivation of wheat with local seeds. It was observed that the amount of crop loss in wheat was significantly higher than that of paddy. In this regard, farmers opined that the seed variety and climatic conditions of the state do not support each other for which the crop is badly exposed to diseases. The farmers reported that the pre monsoon shower at the time of harvesting gives vent to more disease infestation. The loss over actual production was found in between 16.11 and 21.89 per cent across the farm sizes with an overall loss of 15.96 per cent. The loss over the normal production was found in between 13.87 and 17.96 per cent across the farm sizes with an overall loss of 13.76 per cent.

Generally, there are two methods for control of pests and diseases in the crop field as adopted by the respondent farmers- traditional and biological method. Use of chemical pesticides was considered to be a traditional method while biological method takes maximum care against degradation of environment. A large section of the farmers were aware of the danger of indiscriminate use of chemicals. At the same time, the farmers had reports of increasing resistance of pest to some chemicals. In this regard, Integrated Pest Management (IPM) was considered as an useful strategy to combat with the menaces. But the programme is yet to make a breakthrough in the crop field. Table-4.3a, 4.3b and 4.3c give the percentage of sample households adopting different methods along with the cost incurred in weedicide, insecticide, fungicide and labour charge per hectare for crop-I and crop-II across the farm size groups. On an average, 89.17 and 76.67 per cent of the households were found to use chemicals for control of pests and diseases in crop-I and Crop-II, respectively. There was no report of using weedicide in the study area but uprooting of weeds was done manually for both the crops. On an average, per hectare cost for weed control was Rs.753.28 for crop-I and Rs. 986.99 for crop-II. It was reported by the Crop –II

growers that they had to go for weeding at least for two times in a season. To control the pests attack, one time chemical spray was reported to be sufficient enough for each crop. Cost of chemical per hectare also varied with the type of chemicals used and their price.

The overall cost of spraying of insecticides including labour charge was worked at Rs. 655.43 for crop –I and Rs. 684.00 for crop-II /ha.. In case of fungicides, the overall cost incurred was Rs. 621.38 per hectare for crop-I and Rs. 510.31 for crop-II per hectare.

Only 13 households (10.83%) adopted biological method using leaves of Neem tree for pests and diseases control in crop-I.

It was reported that incidence of pest and disease was very much common in the study area for all the field crops. The farmers used to seek technical advice from different sources only when severity of attack went beyond a certain level. Table-4.4 summarizes the farmers' opinion of on different sources of information. Nearly 74.17 per cent of the households sought for technical advice in case of Crop-I and 60.83 per cent for in case of crop-II pests and disease control. **For the growers of crop** (normal fact) **–I,** fellow farmers (39.33%) were the most important source and for crop-II, Government extension agent (45.21%) was the most important source of information. The information & services received by the sample farmers from different agencies were found to be very useful for control of pests and diseases in the field.

Following suggestions are incorporated here on the basis of the interaction with the sample farmers:

- Delay in diagnosis of the attack of pests and diseases often increases pre harvest losses. Most of the times, the farmers are to look for external agencies for mitigation/ control of pest & diseases. Long waiting time results in more pre-harvest losses, therefore timely diagnosis of the problem & quick action thereon deemed necessary.
- Recommended insecticides or pesticides are not always available in the market to take immediate action. Field visit by the officials of the line department at regular interval should be closely monitored & they should arranged for ensuring the availability of required insecticides or pesticides well in advance.
- High input cost stands as an impediment for adoption of full package of technology for pest & diseases management. The Govt. may either go containing the price, or may provide for relief to the poor farmers.

- Farmers are also aware of the probable side effect of agro chemicals which very often deter them to go for its application in the field. They are always interested to adopt other means to mitigate the incidence of pests and diseases. Under the situation, this pesticide may be popularized.
- The prices of the produces are not remunerative. Therefore, the farmers cannot spend much to prevent crop losses due to pests and diseases. Prices may therefore, be fixed on the basis cost of production along with a reasonable margin.
- It was reported that most of the pests and diseases in crops come from the soil first. As such, soil testing before planting/sowing is always recommended so that all the precautionary measures can be taken up well on time.
- Only a section of farmers are aware of IPM/IDM module. But they need adequate training by the competent professionals. The Department may come forward to train them up accordingly.
- The Department may launch massive capacity building programme to train the farmers on latest technology which can reduce the crop losses due to pests and diseases.
- It is said, **"Delay is the enemy of efficiency and waiting is the enemy of utilization."** As such, whenever there is report of pest and diseases infestation, one should immediately resort to protective measure without any time lag.
- Crop losses for any abiotic factors like severe draught and floods are beyond human endeavor.

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Chapter V

Assessment of Post Harvest Losses of Reference Crops

5.1 Production loss during harvest

Here an attempt has been made in order to estimate the post harvest losses of the referred crops during harvesting, transporting, threshing, winnowing and storing.

Table-5.1a depicts the quantity of loss of local and HYV paddy at three different stages, *viz.*, early, mid and late stage. In the study area, a major portion of HYV paddy was harvested in the early and mid part of the season. In case of local paddy, a major proportion of the area was harvested during mid and late season. In early stage, harvesting was undertaken @ 0.16 hectare per household for local paddy and 1.00 hectare for HYV paddy. In mid stage, it was recorded at 0.25 hectare for local paddy and 0.52 hectare for HYV paddy while in late stage, it stood at 0.33 hectare and 0.20 hectare for local and HYV paddy, respectively. In case of HYV paddy, the highest (58.07%) area was harvested at the early stage followed by (30.38 %)) mid stage and the late stage (11.55%). In case of local paddy, the lowest area of 21.79 per cent was harvested in early stage which was increased by 33.13 per cent at the mid stage and 45.08 per cent at the late stage. In all the stages, harvesting (100%) was done manually. Magnitude of qualitative loss was measured in terms of the opinion of the households with 3 degrees of rank across the 3 different stages by variety. In local paddy, 30.00, 32.50 and 26.67 per cent of the households ranked the losses as high in early, mid and late staged, respectively. Similarly, 31.67, 22.50 and 33.33 per cent of households assigned the medium rank and 38.33, 45.00 and 40.00 per cent of households gave low rank in early, mid and late stage of harvesting, respectively. In case of HYV paddy, 29.17, 37.50 and 33.33per cent of the households assigned high rank; 45.83, 35.83 and 36.67 per cent gave the medium rank; 25.00, 26.67 and 30.00 per cent of the households gave low rank in early, mid and late stage of harvesting, respectively. The highest loss of 16.42 kg per hectare was found in late stage of harvesting and the lowest loss of 10.83 kg per hectare was found in early stage harvesting against local paddy while the highest loss of 54.69 kg and the lowest loss of 15.89 kg per hectare was found in late stage and early stage of harvesting against the HYV paddy, respectively. In case of local paddy, quantity lost during harvest occurred at 0.25 kg, 0.40 kg and 0.98 kg per quintal during early, mid and late harvesting, respectively. The corresponding figures, in case of HYV paddy, were to the tune of 0.59 kg, 0.56 kg and 0.96 kg per quintal. The percentage of loss was found in the higher side in case of HYV paddy during the early and mid harvesting period than that of local paddy but the percentage of loss during late harvesting was almost same for both the crop varieties.

Table -5.1a

Quantity lost at different stages of harvest: Crop – I (Paddy)

Stages of harvest and variety		Early		Mid		Late	
		Local	**HYV**	**Local**	**HYV**	**Local**	**HYV**
Area harvested per hh (ha.)		0.16	1.00	0.25	0.52	0.33	0.20
Percentage area harvested (early, mid and late)		21.79	58.07	33.13	30.38	45.08	11.55
Area manually harvested (percentage)		100.00	100.00	100.00	100.00	100.00	100.00
Area mechanically harvested (percentage)		0.00	0.00	0.00	0.00	0.00	0.00
Rank of loss (percentage of households)	High	30.00	29.17	32.50	37.50	26.67	33.33
	Medium	31.67	45.83	22.50	35.83	33.33	36.67
	Low	38.33	25.00	45.00	26.67	40.00	30.00
Quantity lost during harvest	Kg per ha. of harvest	10.83	15.89	12.80	25.57	16.42	54.69
	Kg per quintal of harvest	0.25	0.59	0.40	0.56	0.98	0.96
	Loss % of harvest amount	0.25	0.59	0.40	0.56	0.98	0.96

Source: Primary Data.

Table-5.1b depicts the quantity of loss of wheat at three different stages *viz.*, early, mid and late stages. In the samples, there was no report of cultivation of local wheat. All the farmers used HYV seeds. The size of area harvested per household was found at 0.08 hectare at early stage, 0.13 hectare at mid stage and 0.21 hectare at late stage. The highest percentage of area (49.20%) was harvested at late stage followed by 32.35 per cent at mid stage and 18.45 per cent at early stage and 100 per cent harvesting was done manually. Magnitude of qualitative loss was measured in terms of the opinion of the households with 3 degrees of rank across the 3 different stages. The post harvest losses was ranked high by 55.00, 49.17 and 50.83 per cent of the households at early, mid and late stage, respectively while 27.50, 35.83 and 30.83 per cent ranked as medium at the corresponding stages, respectively. Low rank was assigned by 17.50, 15.00 and 18.34 per cent of the households at early, mid and late stage, respectively. The highest loss of 6.60 kg per hectare was found at early stage of harvesting and the lowest loss of 3.83 kg per hectare was found in late stage of harvesting. Quantity lost during harvest occurred at 1.82 kg, 1.33 kg and 2.79 kg per quintal during early, mid and late harvesting, respectively. The trend of percentage loss of harvested amount was similar to that of loss in terms of kg per quintal of harvest.

Table-5.1b

Quantity lost at different stages of harvest: Crop – II (Wheat)

Stages of harvest and variety		Early		Mid		Late	
		Local	HYV	Local	HYV	Local	HYV
Area harvested per hh (ha.)		0.00	0.08	0.00	0.13	0.00	0.21
Percentage area harvested (early, mid and late)		0.00	18.45	0.00	32.35	0.00	49.20
Area manually harvested (percentage)		0.00	100.00	0.00	100.00	0.00	100.00
Area mechanically harvested (percentage)		0.00	0.00	0.00	0.00	0.00	0.00
Rank of loss (percentage of households)	High	0.00	55.00	0.00	49.17	0.00	50.83
	Medium	0.00	27.50	0.00	35.83	0.00	30.83
	Low	0.00	17.50	0.00	15.00	0.00	18.34
Quantity lost during harvest	Kg per ha. of harvest	0.00	6.60	0.00	4.16	0.00	3.83
	Kg per quintal of harvest	0.00	1.82	0.00	1.33	0.00	2.79
	Loss % of harvest amount	0.00	1.82	0.00	1.33	0.00	2.79

Source: Primary Data.

5.2 Production loss during threshing and winnowing

Most of the sample farmers belonging to the medium and large size group used power tillers, tractors and bullocks for threshing of paddy and wheat. Manual threshing was found in case of marginal and small groups of farmers. A few households growing wheat also reported of using threshing machine. Table 5.2 gives the production loss of paddy and wheat during threshing and winnowing. Of the total sample households for each crop, 18.52 (local paddy), 30.00 (HYV paddy) and 74.17 (wheat) per cent reported of manual threshing. On threshing losses, 22.22, 10.83 and 42.50 per cent of the households ranked high against local paddy, HYV paddy and wheat, respectively. A medium rank of loss was given by 37.04 and 44.17.per cent of households for local and HYV paddy while it was 38.33 per cent in case of wheat. A low rank of loss was assigned by 40.74, 45.00 and 19.17 per cent of households in case of local paddy, HYV paddy and wheat, respectively. The average loss per hectare was recorded at 0.45 kg for local paddy, 0.99 kg for HYV paddy and 0.43 kg for wheat. The average loss (Kg per quintal) was found at 1.04 kg for local paddy, 1.50 kg for HYV paddy and 6.31 kg for wheat.

Manual winnowing was practiced by all those farmers who did their threshing activity manually. Where there is rice mill, the question of winnowing did not arise. However, the respondents had their own opinion on loss in course of winnowing for the referred crops. A high rank of loss during winnowing was assigned by 11.11, 5.83 and 36.67 per cent of households in respect of local paddy, HYV paddy and wheat, respectively. A medium rank was assigned by 25.93, 45.83 42.50 per cent of households

in case of local paddy, HYV paddy and wheat, respectively. And the loss during winnowing was reported to be low by 62.96 per cent of the households in local paddy and 48.33 per cent in case of HYV paddy (HYV paddy) and 20.83 per cent of households in case of wheat. Quantum of loss during winnowing was found at 0.43 kg per hectare for local paddy, 0.85 kg per hectare for HYV paddy and 0.27 kg per hectare for wheat. The average loss stood at 1.01 kg per quintal for local paddy, 0.96 kg per quintal for HYV paddy and 0.55 kg per quintal for wheat.

Table -5.2
Quantity lost during threshing and winnowing

Stages of harvest and variety		Crop - I (Paddy)		Crop - II (Wheat)	
		Local	HYV	Local	HYV
Area/quantity manually threshed (percentage of hh)		18.52	30.00	0.00	74.17
Rank of loss (percentage of households)	High	22.22	10.83	0.00	42.50
	Medium	37.04	44.17	0.00	38.33
	Low	40.74	45.00	0.00	19.17
Quantity lost during threshing	Average loss (Kg per ha.)	0.45	0.99	0.00	0.43
	Average loss (Kg per qtl)	1.04	1.50	0.00	6.31
	Loss % of threshed amount	1.04	1.50	0.00	6.31
Area/quantity manually winnowed (percentage of hh)		18.52	30.00	0.00	74.17
Rank of loss (percentage of households)	High	11.11	5.83	0.00	36.67
	Medium	25.93	45.83	0.00	42.50
	Low	62.96	48.33	0.00	20.83
Quantity lost during winnowing	Average loss (Kg per ha.)	0.43	0.85	0.00	0.27
	Average loss (Kg per qtl)	1.01	0.96	0.00	0.55
	Loss % of winnowed amount	1.01	0.96	0.00	0.55

Source: Primary Data.

5.3 Production loss during transportation and handling

Table- 5.3a depicts the quantity lost during transportation and handling of paddy through different modes of transportation from paddy field to homestead. In the state, there is no system of threshing of paddy in the crop field. Harvesting with straw is done manually. After that it is tied up into small bundles with a slender bamboo rope (*tomal*). Usually, two small bundles (*Dangori*) of harvested paddy with straw are manually carried on shoulder with the help of a *biria (*a type of carrying flat implement made of bamboo of size 5.5 feet having pointed heads*)*. In the sample villages, there was no report of carrying harvested paddy on heads. Although the farmers used different means of transportations, they are to carry the bundles of harvested paddy manually from crop field to the transportation point at road side. Earlier, bullock cart was an important means of transportation in the state of Assam. However, the use bullock cart is disappearing very fast. There was no report of using bullock cart in the study area. In the sample villages, trolleys, mini trucks and others (e.g. hand carts) were used extensively for transportation. The maximum harvested product (85.33 quintal per household) was carried by other

means of transportation (Hand carts) followed by trolley (74.48 quintal/HH), mini truck (63.88 quintal/HH) and head loads (42.51 quintal/HH). On an average, 62.02 quintal paddy per household was overhauled by different modes of transportation. The average distance from the crop field to homestead stood at 1.17 km. The lowest transportation cost of Rs.8.36 per quintal was recorded under other means of transportation and the overall transportation cost stood at Rs.11.80 per quintal. A high rank of loss was assigned by 24.00, 34.38, 27.27 and 7.50 per cent of households in respect of transportation through head load (on shoulder), trolley, mini truck and others, respectively. The rank of was assigned as medium by 36.00, 46.88, 42.42, and 9.17 per cent in respect of transportation through head load, trolley, mini truck and

Table -5.3a
Quantity lost during transportation and handling – Crop - I (Paddy)

Mode of transportation		***Head load**	**Bullock cart**	**Trolley**	**Tempo**	**Mini Truck**	**Others****	**Total**
Average quantity transported (qtls per hh)		42.51	0.00	74.48	0.00	63.88	85.33	62.02
Average distance covered (kms)		0.32	0.00	1.50	0.00	1.22	1.65	1.17
Transportation cost (Rs per quintal)		9.77	0.00	14.00	0.00	18.24	8.36	11.80
Rank of loss (percentage of hh)	High	24.00	0.00	34.38	0.00	27.27	7.50	29.17
	Medium	36.00	0.00	46.88	0.00	42.42	9.17	40.83
	Low	40.00	0.00	18.74	0.00	30.30	5.83	30.00
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	1.38	0.00	1.85	0.00	1.90	1.57	1.67
	% of amount transported	1.38	0.00	1.85	0.00	1.90	1.57	1.67
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	0.53	0.00	0.72	0.00	0.78	0.82	0.71
	% of amount handled	0.53	0.00	0.72	0.00	0.78	0.82	0.71

*Harvested paddy of two big bundles with straw is manually carried on shoulder with the help of a *biria*
**Others indicates Hand cart.
Source: Primary Data.

others, respectively while the corresponding figures for low rank were at 40.00, 18.75, 30.30 and 5.83 per cent for transportation through head load, trolley, mini truck and others, respectively. On an average, 29.17, 40.83 and 30.00 per cent of households ranked as high, medium and low rank towards the loss in transportation. The average amount of loss in kg per quintal came out to be 1.38 kg in head load, 1.85 kg in trolley, and 1.90 kg in mini truck and 1.57 kg in others. The overall amount of loss in transportation of harvested paddy stood at 1.67 kg per quintal. The overall loss in

transportation came out at 1.67 percent. The amount of loss per quintal in handling were at 0.53 kg in head load, 0.72 kg in trolley, 0.78 in mini truck and 0.82 kg in others means of transport with an overall loss of 0.71 kg per quintal. The overall loss amount of loss in handling came out to be at 0.71 per cent.

Table-5.3b depicts the amount of losses of wheat during transportation and handling. There was no report of using bullock cart, Trolley, Tempo or mini truck for transportation of wheat from crop field to homestead. On head load, the average quantity transported came out to be 9.30 quintal per household while it was 7.18 quintal per household in other mode of transportation. The average distance from the crop field to homestead was about 1.48 Km. The average cost of transportation was of Rs.21.06 per quintal for head load and Rs. 34.18 per quintal for others. The rank for the losses in different means of transportation was worked out based on the opinion of the respondents in terms of percentage of households to the total respondents, In this regard, high rank was assigned by 32.50 per cent for head load transportation(on shoulder) and 35.83 per cent for other means of transportation. The losses were ranked medium by 47.50 per cent against head load and 47.50 per cent against others while the low rank was attached by 20.00 per cent for head load transportation and 16.67 per cent of respondents for the other means of transportation. On an average, 34.17, 47.50 and 18.33 per cent of respondents assigned as high, medium and low rank for transportation losses, respectively. The average loss of wheat in kg per quintal during transportation came out at 2.45 kg against head load and 3.44 kg per quintal against other means of transportation. The overall loss in transportation stood at 2.95 kg per quintal. The overall quantity of losses during transportation came out to be at 2.95 per cent. The quantity of loss during handling was 0.97 kg per quintal in head load and 0.42 kg per quintal in other means of transport with an overall loss of 0.69 kg per quintal. The overall quantity of losses during handling remained at 0.69 per cent.

Table -5.3b
Quantity lost during transportation and handling – Crop - II (Wheat)

Mode of transportation		Head load	Bullock cart	Trolley	Tempo	Truck	Others*	Total
Average quantity transported (qtls per hh)		9.30	0.00	0.00	0.00	0.00	7.18	7.73
Average distance covered (kms)		1.26	0.00	0.00	0.00	0.00	1.68	1.48
Transportation cost (Rs per quintal)		21.06	0.00	0.00	0.00	0.00	34.18	30.10
Rank of loss (percentage of hh)	High	32.50	0.00	0.00	0.00	0.00	35.83	34.17
	Medium	47.50	0.00	0.00	0.00	0.00	47.50	47.50
	Low	20.00	0.00	0.00	0.00	0.00	16.67	18.33
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	2.45	0.00	0.00	0.00	0.00	3.44	2.95
	% of amount transported	2.45	0.00	0.00	0.00	0.00	3.44	2.95
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	0.97	0.00	0.00	0.00	0.00	0.42	0.69
	% of amount handled	0.97	0.00	0.00	0.00	0.00	0.42	0.69

Others* indicates Hand cart.
Source: Primary Data

Table-5.3c gives the quantity loss during storage. Mode of storage for paddy was 100 per cent in other type of storage. The detail of this type of storage had already been given below. In case of wheat storage, 100 per cent of grains were stored in plastic bags and kept in a separate room of dwelling houses. The amount of grains stored per hectare was 38.01 quintal for paddy and 18.27 quintal for wheat. Most of the households belonging to marginal and small size group of farmers dried the grains before storing. Medium and large farmers did not dry it before storing. The percentage of households who dried the grains before storing, were 82.16 per cent for paddy and 100 per for wheat. The average period of storage of grains was 292.14 days for paddy and 132.67 days for wheat per household. The storage losses were assigned high rank by 48.98 per cent households in case of paddy and 50.00 per cent in case of wheat. The medium rank was attached by 32.65 per cent and 35.71 per cent household in case paddy and wheat, respectively and low rank was given by 18.37 per cent household in case of paddy and 14.29 per cent in case of wheat. The quantity lost during storage was 0.820 kg per quintal in paddy and 0.260 kg per quintal in wheat due to weight loss; 0.98 kg per quintal in paddy and 1.59 kg per quintal in wheat due to rodent and 0.27 and 0.38 kg per quintal due to fungus for paddy and wheat, respectively. The aggregate cost of storage per quintal of grains was found at Rs 8.75 for paddy and Rs.10.25 for wheat.

Table 5.3c

Quantity lost during storage(Combining local and HYV paddy)

Place of storage*		Crop I (Paddy)				Crop II (Wheat)			
		1	2	3	4	1	2	3	4
Mode of storage (percentage of amount stored)	Open	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Gunny/plastic bag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
	Kothi/bin kutcha, Pucca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Steel drums	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Others	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
Amount stored (Qtls per hh)		0.00	0.00	0.00	38.01	0.00	0.00	0.00	18.27
Percentage of hh who dried before storing		0.00	0.00	0.00	82.16	0.00	0.00	0.00	100.00
Average number of days stored (per hh)		0.00	0.00	0.00	292.24	0.00	0.00	0.00	132.67
Rank of loss in storage	High	0.00	0.00	0.00	48.98	0.00	0.00	0.00	50.00
	Medium	0.00	0.00	0.00	32.65	0.00	0.00	0.00	35.71
	Low	0.00	0.00	0.00	18.37	0.00	0.00	0.00	14.29
Quantity lost during storage (kgs per quintal of storage)	Due to weight loss	0.00	0.00	0.00	0.82	0.00	0.00	0.00	0.26
	Due to rodents	0.00	0.00	0.00	0.98	0.00	0.00	0.00	1.59
	Due to fungus	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.38
Storage cost Rs. per quintal		0.00	0.00	0.00	8.75	0.00	0.00	0.00	10.25

Note: * Kutcha house =1; Pucca house =2; Scientific godown/warehouse =3; Kutcha/pucca grannary =4.
Source: Primary Data

5.4 Capacity utilization of storage by the selected households

In the state, grains are usually stored in granary (*Bharal ghar*) made from bamboo and wood on a platform (made of bamboo and mud mixed with cow dung) at a height of about 4 to 6 feet from the ground. In flood prone area, this height is more. The walls of the granary are made of bamboo and the roof is made of grass thatch (*uloo kher*). The cost of construction of such granary lies between Rs.10, 000.00 to 30,000.00 depending upon the size group of the farmers. Sometimes grains are also stored in big basket (Duli) made of bamboo in a separate room of a dwelling house. But during the field survey, there was no report of such type of storing. In case of

Table 5.4a

Capacity utilization of storage by the sample households

Mode of storage	Crop I (Paddy)			Crop II (Wheat)		
	Capacity (qtls)	Actual storage (qtls)	Capacity utilization (%)	Capacity (qtls)	Actual storage (qtls)	Capacity utilization (%)
Open	0.00	0.00	0.00	0.00	0.00	0.00
Gunny Plastic bag	0.00	0.00	0.00	927.20	927.20	100.00
Kothi/bukhari/bin kachha	0.00	0.00	0.00	0.00	0.00	0.00
Kothi/bukhari/bin made of cement	0.00	0.00	0.00	0.00	0.00	0.00
Steel drums	0.00	0.00	0.00	0.00	0.00	0.00
Others *	8921.41	7442.18	83.42	0.00	0.00	0.00

Note : * indicates store house made of bamboo and wood with C.I sheet and thatch
Source: Primary Data

wheat, plastic bags were used for storing and were kept inside a separate room of the dwelling house. Table-5.4a gives the capacity utilization of the storage structure by the sample households. In case of paddy, the capacity utilization against other mode of storage was reported to be 83.42 per cent and 100 per cent utilization was found in case of wheat grains stored in plastic bags. There was no report of using gunny bags and others mode of storage for both the crops.

Table-5.4b gives the estimate of the post harvest loses in different stages of paddy and wheat cultivation across the farm size groups. In case of paddy, the total post harvest loss was worked out at 5.388 kg, 6.478 kg, 8.025 kg and 9.420 kg per quintal for marginal, small, medium and large farm size groups, respectively. The loss was found to increase from marginal to large group of farm size. The overall loss stood at 7.328 kg per quintal. The total post harvest loss per hectare was 194.51 kg in marginal size group, 231.07 kg for small size group, 267.31 kg for medium size group, and 294.19 kg for large size group with an overall loss of 254.57 kg per hectare.

In case of wheat, the total post harvest loss was computed came out at 8.480 kg, 10.733 kg, 13.449 kg and 14.173 kg per quintal for marginal, small, medium and large farm size groups, respectively with an over loss of 11.709 kg per quintal. The post harvest loss per quintal was found higher in paddy than that of wheat. As the productivity of wheat was much lower than paddy, the per hectare loss in wheat was found to be lower as compared to paddy. The trend of loss from marginal to medium size group was found to increase from 156.17 kg to 245.45 kg per hectare. The overall post harvest loss in case of wheat stood at 213.92 kg per hectare.

Table 5.4b
Total post harvest losses per quintal by farm size

Particulars	Crop - I (Paddy)					Crop - II (Wheat)				
	Marginal	Small	Medium	Large	Total	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg per qtl)	0.477	0.581	0.616	0.807	0.620	1.501	1.897	2.262	2.259	1.980
Quantity lost in threshing (kg per qtl)	0.912	0.982	1.407	1.780	1.270	2.279	2.979	3.881	4.101	3.310
Quantity lost in winnowing (kg per qtl)	0.794	0.882	1.021	1.223	0.980	0.338	0.426	0.607	0.827	0.550
Quantity lost in transport (kg per qtl)	1.296	1.488	1.788	2.109	1.670	2.208	3.057	3.216	3.318	2.950
Quantity lost in handling (kg per qtl)	0.570	0.770	0.760	0.730	0.708	0.532	0.622	0.759	0.847	0.690
Quantity lost in storage (kg per qtl)	1.339	1.775	2.433	2.771	2.080	1.622	1.752	2.724	2.821	2.230
Total post harvest loss (kg per qtl)	5.388	6.478	8.025	9.420	7.328	8.480	10.733	13.449	14.173	11.709
Total post harvest loss (kg per Ha.)*	194.51	231.07	267.31	294.19	254.57	156.71	196.95	245.45	211.74	213.92

Note: Post harvest loss per ha. is calculated by multiplying the losses in kg per quintal by the productivity per ha..
Source: Primary Data

5.5 Quantitative aspects of storage and the pests control measure adopted by the selected households

Here an attempt has been made on the nature of storage structure and pest control measures adopted by the sample households based on visual observations and personal interview with the respondents. Three types of roof (The details have been presented in Table %.5a) were found in the storage structure used by the sample households. In case of paddy, the roof made of grass thatch were found in 31.67 per cent of the households, the roof made of crop by-product (Straw) was found amongst 5.83 per cent of households and the roof made of other means i.e., C.I sheets was found in 62.50 per cent of households. In case of wheat, there was no separate structure for wheat grain storage. It was stored in the dwelling house in a separate room in plastic bags and the roof of each dwelling house was made of C.I. sheets (100 %). The walls of the storage structure were made of burnt brick/cement in 5.83 and 20.83 per cent of the households for paddy and wheat, respectively.

Table-5.5a
Status of storage structures

(percentage of households)

Description		Crop I (Paddy)	Crop II (Wheat)
1. Nature of storage structure			
Roof made of	Grass thatched	31.67	0.00
	Crop by product	5.83	0.00
	Plastic cover	0.00	0.00
	Metal/cemented	0.00	0.00
	Asbestos sheet	0.00	0.00
	Others/C.I. Sheet	62.50	100.00
Walls made of	Burnt bricks/cemented	5.83	20.83
	Woven basket	0.00	0.00
	Mud	0.00	0.00
	Crib	0.00	0.00
	Open wall	0.00	0.00
	Others/Bamboo & Mud	94.17	79.17
Floor made of	Concrete	0.00	20.83
	Earth	0.00	0.00
	Woven basket	0.00	0.00
	Wooden	0.00	0.00
	Others	100.00	79.17
Percentage of households having platform			
Height of the platform	Less than 6 inches	0.00	0.00
	6-12 inches	0.00	0.00
	Above 12 inches	0.00	0.00
	Others (4 to 6 feet)	100.00	100.00
2. Physical condition of storage			
Roof	Leak roof	9.17	10.83
	Good roof	90.83	89.17
Walls	Damaged wall	29.17	0.00
	Good condition walls	70.83	100.00
Guards	Rat guard installed	0.00	0.00
	No rat guards	100.00	100.00
Floor	Cemented good condition roof	0.00	0.00
	Broken floor, mud coming out	100.00	100.00

Source: Primary Data

The walls of the storage structure made of bamboo and mud mixed with cow dung were found in 94.17 per cent of the households in paddy and 79.17 per cent of the households (Kutcha house) in wheat. As the state is situated in high rainfall zone, flood is a very common problem. To protect the stored grains from flood, the height of the platform was found between 4 to 6 feet. Observations on physical condition of the storage structure indicated that nearly 9.17 and 10.83 per cent of households had leaking roof for paddy and wheat storage, respectively. In case of paddy, damaged walls were found in 29.17 per cent of households and no such damages were seen in case of wheat storage. No households were found to install rat guards in the storage structures. The floor of the storage for both the crops was not up to the required level and was mostly broken.

Table -5.5b
Some quantitative aspects of storage

(percentage of households)

Description		Crop I (Paddy)	Crop II (Wheat)
1. Cost of storage			
The average age of the storage structure (years per household)		3.50	12.00
Cost of permanent storage, e.g., steel drums etc. (Rs per household)		0.00	0.00
Cost of kutcha or cemented house for storage (Rs. Per household)		13176.67	18325.74
2. Maintenance status – Frequency of repair of grain storage			
Roof	Every year	5.83	0.00
	Every two years	0.00	0.00
	2-5 Years	31.67	0.00
	No maintenance required	62.50	100.00
Walls	Every year	0.00	0.00
	Every two years	0.00	0.00
	2-5 Years	37.50	0.00
	No maintenance required	62.50	100.00
Rat guards	Every year	0.00	0.00
	Every two years	0.00	0.00
	2-5 Years	0.00	0.00
	No maintenance required	0.00	0.00
3. Storage pests control measures			
Sun drying	Monthly	0.00	0.00
	Quarterly	0.00	0.00
	By-annual	0.00	0.00
	Annual	0.00	0.00
	Never	0.00	0.00
Removal of infested grain from storage and destroying it	Monthly	0.00	0.00
	Quarterly	0.00	0.00
	By-annual	0.00	0.00
	Annual	100.00	100.00
	Never	0.00	0.00
Admixing with ash and other plant materials	Monthly	0.00	0.00
	Quarterly	0.00	0.00
	By-annual	0.00	0.00
	Annual	0.00	0.00
	Never	0.00	0.00
Smoking	Monthly	0.00	0.00
	Quarterly	0.00	0.00
	By-annual	0.00	0.00
	Annual	0.00	0.00
	Never	0.00	0.00
Others	Monthly	0.00	0.00
	Quarterly	0.00	0.00
	By-annual	0.00	0.00
	Annual	0.00	0.00
	Never	0.00	0.00

Source: Primary Data

Table-5.5b is the continuation of some quantitative aspects of storage structures used by the of sample households as per opinion of the respondents. The average age of the structure was 3.50 years in case of paddy while it was 12.00 years in case of wheat as it was kept inside the dwelling house.

No permanent storage structure was seen in the sample villages. The average cost of kutcha storage structure came out to be Rs.13, 176.67 for paddy and Rs.18, 325.74 for wheat. Nearly 5.83 per cent of households had to go for maintenance of roof made of plant material every year while 31.67 per cent of households maintained their roof (made of thatch) in the interval of 2-5 years. However, no frequent maintenance was required by 62.50 per cent of the households as the roofs were made of C.I. sheets. In case of wheat, no frequent maintenance was required for the roof as opined by 100 per cent households. In case of maintenance of walls of paddy storage, 37.50 per cent of households opined that it needed repairing in every 2-5 years, while 62.50 per cent of households opined that no maintenance was required at least for 10 years. In case of wheat, all the sample households reported that no maintenance was required at least for 15 years. No respondents were found to adopt any measure for rat guard in the storage structures of both the crops. There was no report of sun drying to control the storage pests but all the sample households reported that the infested grains from storage structure were removed and destroyed accordingly for both the crops. There was no report of adopting any other measures to control the infestation of grains in the storage structure for both the crops.

5.7 Households suggestion how to minimize post harvest losses

The specific suggestions put forwarded by the sample households to minimize post harvest losses can be summarized as follows:

- A common threshing floor in the vicinity of the crop field may reduce the transportation losses.
- The present storage structures available sample households are not free from pests and rodent attack. The roof made of thatch and by product of the crops is very much prone to leakage of rain water & pests. Agriculture department of the state may promote suitable schemes to support the farmers for construction of grain storage.
- Specific programme may be thought for threshing & storage, on cooperative basis covering 100 to 200 hectares of operational area in each district.

5.8 Summary of the Chapter

In this chapter, an attempt has been made in order to estimate the post harvest losses of the referred crops during harvesting, transporting, threshing, winnowing and storing.

The quantity of loss of local and HYV paddy at three different stages were measured *viz.*, early, mid and late stage. In the study area, a major portion of HYV paddy was harvested in the early and mid part of the season. In case of local paddy, a major proportion of the area was harvested during mid and late season. In early stage, harvesting was undertaken @ 0.16 hectare per household for local paddy and 1.00 hectare for HYV paddy. In mid stage, it was recorded at 0.25 hectare for local paddy and 0.52 hectare for HYV paddy while in late stage, it stood at 0.33 hectare and 0.20 hectare for local and HYV paddy, respectively. In case of HYV paddy, the highest (58.07%) area was harvested at the early stage followed by (30.38 %)) mid stage and the late stage (11.55%). In case of local paddy, the lowest area of 21.79 per cent was harvested in early stage which was increased by 33.13 per cent at the mid stage and 45.08 per cent at the late stage. In all the stages, harvesting (100%) was done manually. Magnitude of qualitative loss was measured in terms of the opinion of the households with 3 degrees of rank across the 3 different stages by variety. In local paddy, 30.00, 32.50 and 26.67 per cent of the households ranked the losses as high in early, mid and late staged, respectively. Similarly, 31.67, 22.50 and 33.33 per cent of households assigned the medium rank and 38.33, 45.00 and 40.00 per cent of households gave low rank in early, mid and late stage of harvesting, respectively. In case of HYV paddy, 29.17, 37.50 and 33.33per cent of the households assigned high rank; 45.83, 35.83 and 36.67 per cent gave the medium rank; 25.00, 26.67 and 30.00 per cent of the households gave low rank in early, mid and late stage of harvesting, respectively. The highest loss of 16.42 kg per hectare was found in late stage of harvesting and the lowest loss of 10.83 kg per hectare was found in early stage harvesting against local paddy while the highest loss of 54.69 kg and the lowest loss of 15.89 kg per hectare was found in late stage and early stage of harvesting against the HYV paddy, respectively. In case of local paddy, quantity lost during harvest occurred at 0.25 kg, 0.40 kg and 0.98 kg per quintal during early, mid and late harvesting, respectively. The corresponding figures, in case of HYV paddy, were to the tune of 0.59 kg, 0.56 kg and 0.96 kg per quintal. The percentage of loss was found in the higher side in case of HYV paddy during the early and mid

harvesting period than that of local paddy but the percentage of loss during late harvesting was almost same for both the crop varieties.

The quantity of loss of wheat at three different stages *viz.*, early, mid and late stages was also worked out. In the samples, there was no report of cultivation of local wheat. All the farmers used HYV seeds. The size of area harvested per household was found at 0.08 hectare at early stage, 0.13 hectare at mid stage and 0.21 hectare at late stage. The highest percentage of area (49.20%) was harvested at late stage followed by 32.35 per cent at mid stage and 18.45 per cent at early stage and 100 per cent harvesting was done manually. Magnitude of qualitative loss was measured in terms of the opinion of the households with 3 degrees of rank across the 3 different stages. The post harvest losses was ranked high by 55.00, 49.17 and 50.83 per cent of the households at early, mid and late stage, respectively while 27.50, 35.83 and 30.83 per cent ranked as medium at the corresponding stages, respectively. Low rank was assigned by 17.50, 15.00 and 18.34 per cent of the households at early, mid and late stage, respectively. The highest loss of 6.60 kg per hectare was found at early stage of harvesting and the lowest loss of 3.83 kg per hectare was found in late stage of harvesting. Quantity lost during harvest occurred at 1.82 kg, 1.33 kg and 2.79 kg per quintal during early, mid and late harvesting, respectively. The trend of percentage loss of harvested amount was similar to that of loss in terms of kg per quintal of harvest.

Most of the sample farmers belonging to the medium and large size group used power tillers, tractors and bullocks for threshing of paddy and wheat. Manual threshing was found in case of marginal and small groups of farmers. A few households growing wheat also reported of using threshing machine. Table 5.2 gives the production loss of paddy and wheat during threshing and winnowing. Of the total sample households for each crop, 18.52 (local paddy), 30.00 (HYV paddy) and 74.17 (wheat) per cent reported of manual threshing. On threshing losses, 22.22, 10.83 and 42.50 per cent of the households ranked high against local paddy, HYV paddy and wheat, respectively. A medium rank of loss was given by 37.04 and 44.17.per cent of households for local and HYV paddy while it was 38.33 per cent in case of wheat. A low rank of loss was assigned by 40.74, 45.00 and 19.17 per cent of households in case of local paddy, HYV paddy and wheat, respectively. The average loss per hectare was recorded at 0.45 kg for local paddy, 0.99 kg for HYV paddy and 0.43 kg for

wheat. The average loss (Kg per quintal) was found at 1.04 kg for local paddy, 1.50 kg for HYV paddy and 6.31 kg for wheat.

Manual winnowing was practiced by all those farmers who did their threshing activity manually. Where there is rice mill, the question of winnowing did not arise. However, the respondents had their own opinion on loss in course of winnowing for the referred crops. A high rank of loss during winnowing was assigned by 11.11, 5.83 and 36.67 per cent of households in respect of local paddy, HYV paddy and wheat, respectively. A medium rank was assigned by 25.93, 45.83 42.50 per cent of households in case of local paddy, HYV paddy and wheat, respectively. And the loss during winnowing was reported to be low by 62.96 per cent of the households in local paddy and 48.33 per cene in case of HYV paddy (HYV paddy) and 20.83 per cent of households in case of wheat. Quantum of loss during winnowing was found at 0.43 kg per hectare for local paddy, 0.85 kg per hectare for HYV paddy and 0.27 kg per hectare for wheat. The average loss stood at 1.01 kg per quintal for local paddy, 0.96 kg per quintal for HYV paddy and 0.55 kg per quintal for wheat.

The quantity lost during transportation and handling of paddy through different modes of transportation from paddy field to homestead was worked out. In the state, there is no system of threshing of paddy in the crop field. Harvesting with straw is done manually. After that it is tied up into small bundles with a slender bamboo rope (*tomal*). Usually, two small bundles (*Dangori*) of harvested paddy with straw are manually carried on shoulder with the help of a *biria (*a type of carrying flat implement made of bamboo of size 5.5 feet having pointed heads*).* In the sample villages, there was no report of carrying harvested paddy on heads. Although the farmers used different means of transportations, they are to carry the bundles of harvested paddy manually from crop field to the transportation point at road side. Earlier, bullock cart was an important means of transportation in the state of Assam. However, the use bullock cart is disappearing very fast. There was no report of using bullock cart in the study area. In the sample villages, trolleys, mini trucks and others (e.g. hand carts) were used extensively for transportation. The maximum harvested product (85.33 quintal per household) was carried by other means of transportation (Hand carts) followed by trolley (74.48 quintal/HH), mini truck (63.88 quintal/HH) and head loads (42.51 quintal/HH). On an average, 62.02 quintal paddy per household was overhauled by different modes of transportation. The average distance from the crop field to homestead stood at 1.17 km. The lowest transportation cost of Rs.8.36

per quintal was recorded under other means of transportation and the overall transportation cost stood at Rs.11.80 per quintal. A high rank of loss was assigned by 24.00, 34.38, 27.27 and 7.50 per cent of households in respect of transportation through head load (on shoulder), trolley, mini truck and others, respectively. The rank of was assigned as medium by 36.00, 46.88, 42.42, and 9.17 per cent in respect of transportation through head load, trolley, mini truck and others, respectively while the corresponding figures for low rank were at 40.00, 18.75, 30.30 and 5.83 per cent for transportation through head load, trolley, mini truck and others, respectively. On an average, 29.17, 40.83 and 30.00 per cent of households ranked as high, medium and low rank towards the loss in transportation. The average amount of loss in kg per quintal came out to be 1.38 kg in head load, 1.85 kg in trolley, and 1.90 kg in mini truck and 1.57 kg in others. The overall amount of loss in transportation of harvested paddy stood at 1.67 kg per quintal. The overall loss in transportation came out at 1.67 percent. The amount of loss per quintal in handling were at 0.53 kg in head load, 0.72 kg in trolley, 0.78 in mini truck and 0.82 kg in others means of transport with an overall loss of 0.71 kg per quintal. The overall loss amount of loss in handling came out to be at 0.71 per cent.

The amount of losses of wheat during transportation and handling were worked out. There was no report of using bullock cart, Trolley, Tempo or mini truck for transportation of wheat from crop field to homestead. On head load, the average quantity transported came out to be 9.30 quintal per household while it was 7.18 quintal per household in other mode of transportation. The average distance from the crop field to homestead was about 1.48 Km. The average cost of transportation was of Rs.21.06 per quintal for head load and Rs. 34.18 per quintal for others. The rank for the losses in different means of transportation was worked out based on the opinion of the respondents in terms of percentage of households to the total respondents, In this regard, high rank was assigned by 32.50 per cent for head load transportation(on shoulder) and 35.83 per cent for other means of transportation. The losses were ranked medium by 47.50 per cent against head load and 47.50 per cent against others while the low rank was attached by 20.00 per cent for head load transportation and 16.67 per cent of respondents for the other means of transportation. On an average, 34.17, 47.50 and 18.33 per cent of respondents assigned as high, medium and low rank for transportation losses, respectively. The average loss of wheat in kg per quintal during transportation came out at 2.45 kg against head load and 3.44 kg per

quintal against other means of transportation. The overall loss in transportation stood at 2.95 kg per quintal. The overall quantity of losses during transportation came out to be at 2.95 per cent. The quantity of loss during handling was 0.97 kg per quintal in head load and 0.42 kg per quintal in other means of transport with an overall loss of 0.69 kg per quintal. The overall quantity of losses during handling remained at 0.69 per cent.

The quantity loss during storage was worked out here. Mode of storage for paddy was 100 per cent in other type of storage. The detail of this type of storage had already been given below. In case of wheat storage, 100 per cent of grains were stored in plastic bags and kept in a separate room of dwelling houses. The amount of grains stored per hectare was 38.01 quintal for paddy and 18.27 quintal for wheat. Most of the households belonging to marginal and small size group of farmers dried the grains before storing. Medium and large farmers did not dry it before storing. The percentage of households who dried the grains before storing, were 82.16 per cent for paddy and 100 per for wheat. The average period of storage of grains was 292.14 days for paddy and 132.67 days for wheat per household. The storage losses were assigned high rank by 48.98 per cent households in case of paddy and 50.00 per cent in case of wheat. The medium rank was attached by 32.65 per cent and 35.71 per cent household in case paddy and wheat, respectively and low rank was given by 18.37 per cent household in case of paddy and 14.29 per cent in case of wheat. The quantity lost during storage was 0.820 kg per quintal in paddy and 0.260 kg per quintal in wheat due to weight loss; 0.98 kg per quintal in paddy and 1.59 kg per quintal in wheat due to rodent and 0.27 and 0.38 kg per quintal due to fungus for paddy and wheat, respectively. The aggregate cost of storage per quintal of grains was found at Rs 8.75 for paddy and Rs.10.25 for wheat.

In the state, grains are usually stored in granary (*Bharal ghar*) made from bamboo and wood on a platform (made of bamboo and mud mixed with cow dung) at a height of about 4 to 6 feet from the ground. In flood prone area, this height is more. The walls of the granary are made of bamboo and the roof is made of grass thatch (*uloo kher*). The cost of construction of such granary lies between Rs.10, 000.00 to 30,000.00 depending upon the size group of the farmers. Sometimes grains are also stored in big basket (Duli) made of bamboo in a separate room of a dwelling house. But during the field survey, there was no report of such type of storing. In case of wheat, plastic bags were used for storing and were kept inside a separate room of the

dwelling house. The capacity utilization of the storage structure by the sample households were also observed during field study. In case of paddy, the capacity utilization against other mode of storage was reported to be 83.42 per cent and 100 per cent utilization was found in case of wheat grains stored in plastic bags. There was no report of using gunny bags and others mode of storage for both the crops.

The estimate of the post harvest loses in different stages of paddy and wheat cultivation across the farm size groups were found as follows. In case of paddy, the total post harvest loss was worked out at 5.388 kg, 6.478 kg, 8.025 kg and 9.420 kg per quintal for marginal, small, medium and large farm size groups, respectively. The loss was found to increase from marginal to large group of farm size. The overall loss stood at 7.328 kg per quintal. The total post harvest loss per hectare was 194.51 kg in marginal size group, 231.07 kg for small size group, 267.31 kg for medium size group, and 294.19 kg for large size group with an overall loss of 254.57 kg per hectare.

In case of wheat, the total post harvest loss was computed came out at 8.480 kg, 10.733 kg, 13.449 kg and 14.173 kg per quintal for marginal, small, medium and large farm size groups, respectively with an over loss of 11.709 kg per quintal. The post harvest loss per quintal was found higher in paddy than that of wheat. As the productivity of wheat was much lower than paddy, the per hectare loss in wheat was found to be lower as compared to paddy. The trend of loss from marginal to medium size group was found to increase from 156.17 kg to 245.45 kg per hectare. The overall post harvest loss in case of wheat stood at 213.92 kg per hectare.

Here an attempt has been made on the nature of storage structure and pest control measures adopted by the sample households based on visual observations and personal interview with the respondents. Three types of roof (The details have been presented in Table %.5a) were found in the storage structure used by the sample households. In case of paddy, the roof made of grass thatch were found in 31.67 per cent of the households, the roof made of crop by-product (Straw) was found amongst 5.83 per cent of households and the roof made of other means i.e., C.I sheets was found in 62.50 per cent of households. In case of wheat, there was no separate structure for wheat grain storage. It was stored in the dwelling house in a separate room in plastic bags and the roof of each dwelling house was made of C.I. sheets (100

%). The walls of the storage structure were made of burnt brick/cement in 5.83 and 20.83 per cent of the households for paddy and wheat, respectively.

The walls of the storage structure made of bamboo and mud mixed with cow dung were found in 94.17 per cent of the households in paddy and 79.17 per cent of the households (Kutcha house) in wheat. As the state is situated in high rainfall zone, flood is a very common problem. To protect the stored grains from flood, the height of the platform was found between 4 to 6 feet. Observations on physical condition of the storage structure indicated that nearly 9.17 and 10.83 per cent of households had leaking roof for paddy and wheat storage, respectively. In case of paddy, damaged walls were found in 29.17 per cent of households and no such damages were seen in case of wheat storage. No households were found to install rat guards in the storage structures. The floor of the storage for both the crops was not up to the required level and was mostly broken.

Some quantitative aspects of storage structures used by sample households as per opinion of the respondents were also observed during field study. The average age of the structure was 3.50 years in case of paddy while it was 12.00 years in case of wheat as it was kept inside the dwelling house.

No permanent storage structure was seen in the sample villages. The average cost of kutcha storage structure came out to be Rs.13, 176.67 for paddy and Rs.18, 325.74 for wheat. Nearly 5.83 per cent of households had to go for maintenance of roof made of plant material every year while 31.67 per cent of households maintained their roof (made of thatch) in the interval of 2-5 years. However, no frequent maintenance was required by 62.50 per cent of the households as the roofs were made of C.I. sheets. In case of wheat, no frequent maintenance was required for the roof as opined by 100 per cent households. In case of maintenance of walls of paddy storage, 37.50 per cent of households opined that it needed repairing in every 2-5 years; while 62.50 per cent of households opined that no maintenance was required at least for 10 years. In case of wheat, all the sample households reported that no maintenance was required at least for 15 years. No respondents were found to adopt any measure for rat guard in the storage structures of both the crops. There was no report of sun drying to control the storage pests but all the sample households reported that the infested grains from storage structure were removed and destroyed accordingly for both the

crops. There was no report of adopting any other measures to control the infestation of grains in the storage structure for both the crops.

The specific suggestions put forwarded by the sample households to minimize post harvest losses can be summarized as follows:

- A common threshing floor in the vicinity of the crop field may reduce the transportation losses.
- The present storage structures available sample households are not free from pests and rodent attack. The roof made of thatch and by product of the crops is very much prone to leakage of rain water & pests. Agriculture department of the state may promote suitable schemes to support the farmers for construction of grain storage.
- Specific programme may be thought for threshing & storage, on cooperative basis covering 100 to 200 hectares of operational area in each district.

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Chapter VI

Concluding remarks and policy suggestion

Crop losses occur due to two types of factors- abiotic and biotic factors. Crop losses due to abiotic factors like flood, draught and other natural factors are beyond the ambit of the present study. An attempt in this study has been to assess the losses caused by the biotic factorsonly. Crop losses due to biotic factors such as pest and diseases, weeds, stray cattle, rodents, birds, etc. can be controlled to a great extent if proper measures are taken at the right time.

Table-6(a)
Estimates of the losses of the crops under study

Crop	No. of Sample households	Total Area (In ha.)	Total production (In quintal)	Estimated Losses over actual production (In quintal)	Estimated Losses/Ha. (In quintal in grain)	Estimated Losses/Ha. (In quintal in rice)	Estimated Percentage of losses
Pre harvest losses							
Paddy	120	225.94	7442.18	562.59	2.49	1.66	7.56
Wheat	120	50.05	927.20	148.15	2.96	2.96	15.98
Post harvest losses							
Paddy	120	225.94	7442.18	576.15	2.55	1.70	7.74
Wheat	120	50.05	927.20	107.11	2.14	2.14	11.55
Total losses							
Paddy	120	225.94	7442.18	1138.74	5.04	3.36	15.30
Wheat	120	50.05	927.20	255.26	5.10	5.10	27.53

Source: Primary data

The Table-6(a) have been prepared on the basis of the detail estimate of the pre and post harvest losses of the crops in terms of production and productivity of mandated crops (Ref. Table 4.2d & 4.2e). The losses, in case of paddy were worked out in terms of rice using conversion percentage (66.67% of rice against per quintal paddy).Both local and HYV paddy were combined to draw an estimate in pre and post harvest losses.

From the analysis of primary data, it was observed that the overall crop losses (combining pre and post harvest loss) in paddy stood at 1138.74 quintal out the actual total production (7442.18 quintal) of the sample area constituting 15.30 per cent loss with per hectare loss of 5.04 quintal. Similarly, in case of wheat, the loss was recorded to be at 255.26 quintal out of the actual production of 927.20 quintal, with a loss of 27.53 per cent. The per hectare loss of wheat came out at 5.10 quintal.

On the basis of these findings, an estimate of losses was also worked out with state level rice and wheat data for the year 2011-12 and is depicted in Table-6(b). Rice

is the principal food of Assam. A large proportion of the population has the habit of taking two meals a day where rice is the main food item. On that count the losses for the state as a whole was worked out at 8.56 lakh MT (in terms of rice) which was valued at Rs. 1539.82 at the prevailing market rate of Rs.1800 per quintal in the reference year. Again, per capita per day requirement of rice is recorded to be 295.25 gram. With these normative requirements, the lost amount (8.56 lakh MT) would be able to feed an estimated population of 79.30 lakh for the reference year. Similar calculation was made for wheat crop as well and the estimated loss of wheat was worked out at 0.20 lakh MT which worth Rs.40.80 crores at existing market rate of Rs.2000 per quintal. If daily requirement is estimated at 220 gram per capita, it would be able to feed 2.49 lakh population. These figures were over and above the losses from natural calamities like flood, draught, etc.

Table-6(b)
Estimated losses in terms of kind and cash and the estimated population to be fed from the losses.

Crop	**Area** (In lakh Ha.)	**Estimated loss** (In Lakh MT)	**Estimated loss** (In crores Rs.)	**Estimated Percapita/day requirement**	**Estimated population to -be fed from Estimated Loss** (in Lakh)
Rice	25.46	*8.56*	1539.82	295.75 gm	79.30
Wheat	0.40	0.20	40.80	220.00 gm	2.49

Source: Primary and secondary data.

Pre and post harvest losses in terms of grains at different stages is a great loss to the state economy as a whole in general and the farmers in particular. Such losses increase the cost of harvesting per unit of production.

The following policy suggestions can be put forwarded on the basis of field observation/ investigation:

1. Practically speaking the crop losses cannot be brought down to zero level but it can be reduced to a great extent if appropriate measures can be adopted on time. Some losses can be reduced substantially if the manual operation at different stages can be replaced by machines.
2. In case of paddy, pre and post harvest losses did not have much difference but In case of wheat, pre and post harvest losses were much higher than that of paddy. Therefore, more attention is deemed necessary.
3. Post harvest cooperative farm may be established in the rice and wheat belt areas well equipped with harvesters, threshing machines, *etc,* so that the

farmers can avail the facilities on custom hiring basis. Construction of common godown may also be encouraged among local farmers with the support from various agencies. NGO may play an important role in this regard. It is considered feasible to establish one such cooperative society for 300 hectares of land. The private investor may also be encouraged in this endeavour.

4. Any kind of losses is a matter of serious concern not only to the poor farmers but also for the state as whole from the economic point of view. Therefore, area specific strategy must be worked out to reduce the losses.
5. The CACP data reveals that the cultivation of paddy has become a loss making practice in recent years in Assam compared with market price of paddy. It needs a review to protect the interest of the farmers. Introduction of MSP for paddy in Assam during 2010-11 is a ray of hope for the farmers. Under this situation, measures to reduce the crop losses bear much significance.
6. Food grain banks may be introduced in the paddy belt area which will reduce the risk of grain damage at household level. Also such venture will serve as an authentic data base of food-grain production. It may be encouraged under public as well as private sector.
7. It is said "The bureaucracy needs performers who deliver, not expert who talks". There are many progarmmes launched by the Government and other agencies for the benefit of the farmers. The bureaucracy should come closer to the field to educate the farming community on the on the enormity of the problem of crop losses and to aid and assist them to come out of this depressing situation.

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Annexure

Action Taken Report on comments of the Coordinating Centre, (Institute for Social and Economic Change, Banglore- 560072) on Draft report **"Assessment of Pre and Post Harvest Losses in Paddy and Wheat in Assam"**

1. **Title of the draft report examined:**

   Assessment of Pre and Post Harvest Losses in Selected Crops- A Study in Assam

2. **Date of receipt of the Draft report:** 8 July 2013

3. **Date of dispatch of the comments:** 10 July 2013

4. **Comments on the Objectives of the study:**

   All the objectives of the study have been addressed

5. **Comments on the methodology:**

   Common methodology proposed for the collection of field data and tabulation of results has been followed. However, estimates in some tables should be changed for uniformity and comparisons of results across the states.

6. **Comments on analysis, organization, presentation etc.:**

(i) Authors are requested to change the title of the report to **"Assessment of Pre and Post Harvest Losses of Paddy and Wheat in Assam"** in the same style as has been followed by other AERCs.

Action: Done as per suggestion.

(ii) It may be useful to provide summary of sampling (distribution of respondents) by crops, districts and farm size groups in Chapter I under section 1.6, page 14.

Action: A new Table- 1.15 has been incorporated in Chapter I under section 1.6, page 15 to indicate the summary of sapling design.

(iii) In page 15 and section 1.7 authors should describe the chapters in running paragraph(s). Details of Chapters including sub-heading may be utilised for Contents page.

Action: Done as per suggestion.

(iv) The first part of the Chapter II deals with growth rate of rice and wheat in Assam. It is highly confusing from growth rate in Table 2.1 and 'trend of growth' presented in Figure I to XV that why different approaches viz., compound growth rates and trend growth rates through simple linear function, quadratic function and cubic functions, have been followed to estimate growth rates. There is little explanation of these functions in the text and also usefulness of these graphs. Authors are requested to adopt

any standard approach, perhaps compound annual growth rate (CAGR), to estimate growth rates and present them in the report.

Action: As suggested, all the figures has been dropped and incorporated a new table showing the time series data from 2000-01 to 2010-11 with the CGR of area, production and productivity.

(v) Results provided in Table 3.4, page 35, need to be recalculated. The values should add to 100 by farm size categories.

Action: Done as per suggestion.

(vi) As per the data provided in Table 3.5, area under vegetables has accounted for about 10 per cent of GCA. Kindly provide the name of vegetables in a note below the table. Further, authors may remove yield of vegetables given in value terms in Table 3.7 as it is consistent.

Action: Done as per suggestion.

(vii) In Chapter IV, Table 4.1 should be modified. From the current results given in this table, it is not possible to state the proportion of the famers out of the total sample farmers who have faced a particular constraint in the study area and how each of the constraints has been ranked by these farmers. Therefore to obtain appropriate results, estimate the percentage of households out of total sample households (i.e., 120 households for each crop) rather than the sum of households falling within each constraint.

Action: Done as per suggestion.

Table 4.2b and Table 4.2c should also be modified in the light of the comment (vi). That is, estimate the percentage of households by each rank out of total sample households (i.e., 120 households) rather than the sum of households falling within each pest/disease/weed category.

Action: Done as per suggestion.

(viii) Please check the data on weedicide provided in Table 4.3a and Table 4.3b. As per the table, the number of sprays/ha is one, but cost of chemicals given is zero. Further, discussion in the text refers to the manual weeding practiced by the sample farmers. There appears to be inconsistency in data across chemical methods.

Action: Inconsistency has been corrected in Table 4.3a and Table 4.3b, as in the sample area there was no report of using weedicide.

(ix) In Chapter V, Table 5.1a and Table 5.1b, calculate the percentage of households for rank of loss vertically (high, medium and low) for each period and variety. Please refer Tables 5.2 and 5.3(a-c) in the report where it has been worked out correctly.

Action: Done as per suggestion.

(x) In Table 5.3a, page 71 and Table 5.3b, page 73, please recheck the % amount lost as they are quite varied to a large extent from average loss.

Action: Verified and corrected as suggested.

7. Overall view on acceptability of report of the coordinating centre:

Overall, report is prepared well. Authors are requested to incorporate all the comments and submit the final report for consolidation.

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